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ABSTRACT

This unit, one of a series designed to develop and foster an understanding of the marine environment, presents marine science activities for grade 6 students. The unit is divided into the following sections: (1) Pagoo (story of a hermit crab); (2) introduction to marine environments; (3) salt water environment; (4) sea water investigations; (5) physical features of the marine environment; (6) oceanographic instruments; (7) beach environmental conditions; (8) biological environment; and (9) understanding the environment. Each section has a student text with related activities. Each student text is preceded by a teacher section containing hints on how to use the section, additional information, and items requiring advanced planning. Each activity is also preceded by a teacher background section providing additional information about the activity, including teaching hints and answer key for activities. Important vocabulary words/terms are listed in the teacher background sections; they are also underlined in the student text. Activities are designed to enhance reading as well as investigational skills; several activities provide practice in mathematics skills. Although all activities can be modified to suit individual needs or used "as is," it is strongly recommended that they be performed along with the readings/discussions found in student text material. (JM)

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MARINE SCIENCE ACTIVITIES

THE MARINE ENVIRONMENT

GRADE SIX

MARINE SCIENCE CENTER
MARINE SCIENCE PROJECT: FOR SEA
Educational Service District 114
Poulsbo, Washington 98310

ESEA TITLE IV-C
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Author/Editor

MARINE SCIENCE ACTIVITIES - THE MARINE ENVIRONMENT - GRADE SIX

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MARINE SCIENCE ACTIVITIES - THE MARINE ENVIRONMENT

GRADE SIX

INTRODUCTION

The history of the United States is strongly tied to the seas. The future of the United States will also be strongly tied to the marine world. It is important that the leaders and the citizenry alike have a familiarity with the marine environment that will permit them to make wise choices in resolving the conflicts that are sure to arise over use of the ocean's resources. Marine Science Activities-The Marine Environment is designed to contribute to the knowledge necessary to make these sound decisions. In the development of the Sixth Grade Marine Science Activities - The Marine Environment, our goal has been to provide an opportunity for both the teacher and the student to become aware of the living and non-living factors that shape the life of the sea.

This unit has been designed to be used in its entirety or just in part. It is recommended that the teacher incorporate his or her own ideas, experiences, and background to elaborate the subject material. It is important to develop the natural enthusiasm children have for learning about the sea. This is the time to add a bulletin board dealing with the marine world to your classroom. Displays of living and non-living marine creatures are also recommended. Use your imagination to create an exciting classroom atmosphere. National Geographic magazines are excellent scources of pictures. Incorporate some of the books listed in the Children's Books about the Marine Environment section into your reading program. Investigate the audio-visual materials available from your supplier. Have students bring in their shell collections and other related items. This unit has the potential for not only being worthwhile, it can be fun!

The unit is divided into several sections. Each section has a student text and student activites. Each student text is preceded by a Teacher Background section which contains hints on how to use the section, additional information, and items for which advanced planning is required. Each activity is also preceded by a Teacher Background section. This section gives additional information about the activity including teaching hints and answer key. Skim the contents of the unit to discover the organizational scheme. Please read the text and activities before you use them. The materials have all been prepared with ease of publication in mind. Please feel free to duplicate any and all materials you need to effectively utilize this unit with your class. Important vocabulary terms are listed in the Key Word section of the Teacher Background. They are also underlined in the text. The words are defined in the text, either directly or by context. All of the units have activities accompanying the text. Most require few materials. It is strongly recommended that the activities be performed along with the reading and discussion of the text. Most require few materials. It is strongly recommended that the activities be performed along with the reading and discussion of the text. The activities are designed to enhance reading skills as well as investigational skills. Some activities provide practice in math skills. The activities can be modified to suit your particular needs but will work "as is".

The unit also incorporates a variety of laboratory experiences using live animals and related equipment at the Marine Science Center.

In addition, the teacher is given the opportunity of inservice assistance with the unit as well as the opportunity to use the many resources available through the Marine Science Center staff. Our staff is available to you to give assistance in providing resource material and in setting up the unit of study. Please contact one of our staff members by calling (206) 779-5549.

A list of resource people that are willing to be involved and assist you with your unit of studies is listed in the resource portion of this unit.

At the end of the text and activity section, you will find a send-in page. We would like you to use it to let us know how much you liked or disliked the unit. If you have some marine activity that you have tried successfully with children, please let us know about it. Perhaps we can incorporate it in future revisions.

This unit is one of a series designed to develop and foster an understanding of the marine environment. Other units in the series include:

Marine Science Activities	Grade 2
Marine Science Career Awareness	Grade 4
Marine Biology and Oceanography	Grades 7 - 9
Marine Biology and Oceanography	Grades 9 - 12

Marine Science Activities - The Marine Environment Grade 6 has been prepared with funds from ESEA Title IV-C Grant Number 35462 administered by Educational Service District 114 and the Superintendent of Public Instruction.

James A. Kolb
Project Developer
Author/Editor

A CONCEPTUAL SCHEME FOR MARINE AND COASTAL ENVIRONMENT STUDIES

BY MAURA BEENS TYRRELL AND ROBERT W. STEGNER

1. AN ABUNDANCE OF WATER MAKES THE EARTH UNIQUE IN OUR SOLAR SYSTEM.

- 1.1 Water has a unique combination of chemical and physical properties.
  - 1.11 The chemical and physical behavior of water results in part from the geometry of the water molecule.
  - 1.12 Within the range of temperatures encountered on earth, water exists in three states: solid, liquid, and gas.
  - 1.13 Water exchanges large amounts of heat as it changes in state.
- 1.2 Water in the environment contains a variety of substances in suspension and in solution.
  - 1.21 Water is a very effective solvent.
  - 1.22 Dissolved and suspended substances affect the properties of water.
  - 1.23 Water in nature usually contains gases, organic compounds and mineral salts.
  - 1.24 Many elements dissolved in water are recycled through biological, geological, and chemical systems.

2. AQUATIC ENVIRONMENTS INTERACT WITH THE EARTH AND ITS ATMOSPHERE.

- 2.1 Most of the earth's water is in the oceans.
  - 2.11 Oceans formed early in the history of the earth.
  - 2.12 The earth's surface water is constantly recycled through the oceans.
- 2.2 The ocean waters are influenced by the earth's rotation, revolution, and position in the solar system.
  - 2.21 Ocean current patterns are affected by the absorption of solar energy.
  - 2.22 Ocean current patterns are affected by the earth's rotation.
  - 2.23 Tides result from gravitational forces of the earth, the moon, and the sun.
- 2.3 Energy is transferred wherever bodies of water meet the land or atmosphere.
  - 2.31 Atmospheric movements generate waves, surface currents, and coastal winds.
  - 2.32 Moving water shapes land forms.
  - 2.33 Subsurface topography is constantly changing.
  - 2.34 Land and sea floor movements generate waves.
  - 2.35 The aquatic environment helps to stabilize the earth's climate.

2.4 Materials carried from land masses influence the physical and chemical features of rivers, lakes and coastal zones.
2.41 Water, ice and wind carry minerals, nutrients, sediments and fresh water into rivers, lakes and coastal zones.
2.42 Fresh water from the land dilutes the coastal water.

3. AQUATIC ORGANISMS INTERACT IN COMPLEX ECOSYSTEMS.

3.1 Life probably originated in the marine environment.
3.11 Water facilitated the chemical evolution of organic compounds and coacervates.
3.12 Chemical evolution resulted in heterotrophic systems.
3.13 Autotrophs evolved from heterotrophs.
3.14 Aquatic environments have supported the evolution of a diversity of species.
3.2 Aquatic organisms are adapted to their environments in different ways.
3.21 Aquatic organisms are adapted developmentally, structurally, functionally, and behaviorally to their environments.
3.22 Organisms in aquatic communities interact in balance with their environment and with one another.
3.23 Populations of aquatic organisms are unevenly distributed.
3.3 Aquatic ecosystems depend on a constant flow of energy and the recycling of materials.
3.31 Energy for the maintenance of aquatic ecosystems comes from the sun.
3.32 Aquatic plants convert solar energy to food energy.
3.33 Aquatic organisms transfer energy and materials through food webs.
3.34 Aquatic bacteria reduce organic materials to simpler forms.

3.4 The stability of aquatic ecosystems tends to be directly proportional to the diversity of their populations and the complexity of relationships among them.

4. PEOPLE ARE PART OF AQUATIC ECOSYSTEMS.

4.11 Aquatic environments have affected the course of history and the development of human cultures.

4.11 Oceans, lakes, and rivers have served as routes for the dispersal of human populations and cultures and for commercial transport.
4.12 Proximity to aquatic environments and the availability of aquatic resources have influenced the cultures of many societies.
4.2 People's activities may alter the aquatic ecosystem.
4.21 People collect and culture aquatic resources.
4.22 Exploitation of aquatic environments can cause depletion of many marine and freshwater species and the degradation of habitats.
4.23 People are changing aquatic ecosystems by adding pollutants to land, to air and to water.
4.3 Existing technology is capable of maintaining the health and usefulness of aquatic ecosystems.
4.31 The maintenance of the health and usefulness of aquatic environments depends on value judgments and ethical considerations.
4.32 Regional and international agreements will be essential for the conservation of aquatic resources.

MARINE AQUARIA IN THE CLASSROOM

From kindergarten to graduate school the marine aquarium arouses interest and enthusiasm. Traditionally, marine aquaria have been very expensive and difficult to operate. The recent technological improvements have reduced the cost and labor involved in maintaing a marine aquarium. Teachers should give every consideration to the establishment of a marine aquarium in the classroom.

Before embarking on a marine aquarium project, some basic questions need to be resolved. These include: How much can I afford (do I want) to spend in time? in effort? A very simple set-up to keep hermit crabs can be had for a few dollars while an elaborate temperature-controlled aquarium can cost thousand dollars.

Regardless of the type of aquarium chosen some facts pertain to all:

1. Aquarium tank	- use only tanks made from all glass, plastic, epoxy-coated wood, or fiberglass. No metal edges. While a 10 gallon aquarium may be used in some cases, 20 gallon size is the preferred minimum.
2. Sub-gravel filter	- a good sub-gravel filter should be employed to help control biological wastes.
3. Air pump	- you can seldom have too much air. Get a pump with a capacity high enough to effectively run the sub-gravel filtration system.
4. Gravel filtrant	- use dolomite, crushed coral rock, or crushed oyster shell. Builders gravel has iron and similiar materials which will harm or kill marine organisms.
5. Thermometer/Hydrometer	- tools useful in determining the salinity and temperature of the water.
6. Seawater	- Synthetic sea salts may be used to make salt water solutions if you are more than a day's drive from natural seawater.
7. Food	- Depends upon the type of organism. Use only high quality foods and remove uneaten food from aquarium.

If you buy a marine aquarium kit, instructions for set up will be included. Otherwise, a few hints are given below:

1. Talk to people who have had marine aquaria. (e.g. other teachers, pet shops, etc.) Their assistance can be invaluable.
2. Place the aquarium in desired location. Away from direct sunlight but near an electrical outlet.
3. Install sub-gravel filter.
4. Wash gravel in tap water. Spread evenly over the filter.
5. Fill tank with correct amount of water needed to make sea salt solution (follow directions of manufacturer). Or fill to 1 or 2 inches from top with natural sea water if available.
6. Run filtration system for 24 hours to mix solution.
7. Shut off filter. Check specific gravity by floating hydrometer and reading it at the water-line: it should read between 1/021 and 1.023 when the water temperature is 68-77° F (20-25° c). If necessary adjust by adding tap water to lower reading.
8. Run filter for 14 days. Some aquarists recommend placing one or two hardy specimens in the tank for this period. If available, hermit crabs or the like should be added to help condition the water.
9. Add specimens to tank. If you order the animals from a biological supply house they will come with directions. Otherwise, open each plastic bag of specimens in subdued light and float it on top of the water in the aquarium for 15 to 30 minutes. In this period trickle water from the tank into the bags to slowly equalize temperature and salinity. This is the crucial step. Now add animals to tank, one at a time. (If animals act nervous or contract, stop operation until they have adjusted.)
10. The specimens will live several months without being fed, but to keep them healthy adopt a simple, regular feeding program. Feed carnivorous invertebrates (sea anemones, crabs, horseshoe crabs, starfish, etc.) once a week: they take small minnows, shrimp, earthworms, bits of lean beef. Filter-feeders (barnacles, hydroids, sea cucumbers, clams, etc.) eat Daphnia, brine shrimp, algae, protozoa, or dried fish foods. Herbivorous species (sea hares, sea urchins, turbo snails, etc.) may be fed lettuce or spinach.

Avoid water pollution--remove all uneaten food.

Once the system is operating, care is easy. Each day, a person familiar with the aquarium should check filters and specimens. Dead animals must be removed at once. Add tapwater as often as necessary to keep water at level marked. Do not add salt water since this will increase the salinity.

Though sea-salts don't disintegrate, specimens will stay healthier with partial water changes at regular intervals. Suggestion: once a month, add a few gallons of new seawater solution after siphoning off same amount from tank.

For algae control, scrape tank walls every two weeks.

The above suggestions apply to all marine aquaria. If you live in a Northern latitude, and want to keep local cold water species, you will need a refrigeration unit of some description. Instructions for home-made units can be found in reference books on marine aquaria. Ready-made refrigerated aquaria are available and expensive.

If after reading the above, you are discouraged, take heart. Hundreds of teachers are operating successful in-class marine aquaria. The technical problmes can be overcome. If you feel that it is unquestionably "out of your league" and you cannot obtain help from another source, do not completely forsake the idea. A simple aquarium for hermit crabs can be set up for a very few dollars. Solicit donations from students--all glass aquaria are plentiful. Go to a pet shop and buy a hermit crab or two and get instructions on how to keep them alive. It can be fun! At the very least, set up a freshwater aquarium with goldfish or tropical fish so that you can use a living example when you talk about aquatic organisms. Here is a real opportunity to use all that creativity that got you into teaching in the first place. Good luck!

RECOMMENDED READING

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King, John M. and Spotte, Stephen	*Marine Aquariums in the Research Laboratory.* Aquarium Systems Inc. 33208 Lakeland Blvd. Eastlake, Ohio 44094. 1974 Describes tank set up and maintenance as well as offering experiments which can be performed using marine aquaria. Also advertises Instant Ocean products. 39 pages. ($2.00)
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OF THE
SEA
TEXAS A&M UNIVERSITY

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PAGOO

TEACHER BACKGROUND - Pagoo

The book Pagoo will serve as background for The Marine Environment unit. The activity that follows will take about 15 minutes a day and may be incorporated into the Language Arts instruction. Current research seems to indicate that most teachers stop reading aloud to their classes after the fourth grade. Research also seems to indicate that older students both enjoy and benefit from oral reading. This activity will provide you with the opportunity to share Pagoo while improving your students' listening skills. Developing listening skills is an integral part of a comprehensive reading program.

Pagoo is the story of a hermit crab. The author, Holling C. Holling, has written several acclaimed books focusing on wildlife but spreading into works of men and the sweep of history. The book is scientifically accurate. It is also interesting and enjoyable reading. It is strongly recommended that you plan to use the book to provide the intellectual setting for the study of the marine environment.

Published by the Houghton Mifflin Company in Boston in 1957, Pagoo consists of 20 chapters of three pages each. It is intended that one chapter will be covered each day. Activities correlated with each chapter may be performed throughout the school day. This is a golden opportunity to "marinate" your curriculum. You should make a special effort to refer the concepts dealt with in the other readings and activities to the central ideas presented in Pagoo. In the Instructional Procedures section that follows, you will find a list of new vocabulary, new animals, and new plants for each chapter. Most of these new items are will defined in the story and students may discover them just by listening to the chapter, without prior explanation.

Master drawings of the principal characters of Pagoo are provided for making copies for your students. After they have listened to a chapter, you may pass out the drawing for that chapter. Students should be required to list characteristics of the animal shown. Characteristics should be of a physical nature (e.g. number of legs) as well as of a behaviorial nature (e.g quick to escape enemies). You may choose the number of characteristics that your class should find. Provide reference books for them to pursue during the course of the day. Students may elaborate on the drawings if they so desire (add water, etc.). Punch the separate pages and begin to "bind" them with paper fasteners so that each student may have a marine science reference "book" at the end of Pagoo. (There are no drawings for chapters 7, 16, 17, 19 and 20.)

A packet of slides showing marine animals, plants, and shells is included. It is suggested that the teacher select the slides a few at a time and use them to introduce some of the organisms which will be encountered with each lesson. There is also a list of books where pictures of these organisms can be found, and a list of children's books for further study.

It is recommended that the teacher find samples of the shells named in Pagoo so that the student may know how they feel and what they look like.

A marine aquarium is strongly recommended for the classroom, providing firsthand experience for the children. Hermit crabs, snails, starfish, and other types of marine organisms can readily be obtained along the coast. Inland, pet stores and biological supply houses can provide these organisms. For instructions on collecting and maintaining organisms for a marine aquarium, see the section of this guide entitled "Marine Aquaria in the Classroom."

This activity can provide an interesting experience for both student and teacher. Do not be afraid to attempt it. The results will be gratifying.

The activity Pagoo is adapted from a unit by Cooke and Stegner and the Project COAST group at the University of Delaware.

INSTRUCTIONAL PROCEDURES

SCHEDULE:

Day 1: Chapter 1 -- "Pagoo Might Be A Hermit Crab," pages 8-11. Materials needed: Masters #1 (Larval Hermit Crab) and #2 (Plankton: A. Jellyfish Medusa, B. Larval Spiny Lobster, C. Copepod, D. Young Shrimp, E. Diatoms, F. Young Squid).

Before the children know that they will be learning about a hermit crab and other animals in a tidal pool, pass out copies of #1 Larval Hermit Crab. Ask questions about the picture before you begin to read. Suggested questions:

IS THIS A PLANT OR AN ANIMAL?
HOW MANY LEGS DOES IT HAVE?
HOW MANY FINGERS OR TOES DOES EACH LEG HAVE?
WHAT DO HIS FINGERS LOOK LIKE? (FEATHERS)
DO YOU SEE EYES?
WHERE DO YOU THINK THIS ANIMAL LIVES? (WATER)
HOW CAN HE SWIM?
DO YOU THINK HIS SKIN IS HARD OR SOFT?
HOW BIG DO YOU THINK HE IS?

The next step may be done in the afternoon or it may immediately follow. Show them Pagoo and tell the class that the drawing is a baby hermit crab, and that you are going to be reading Pagoo for the next few weeks. (Be ready for the usual moans and groans.)

If there is a marine aquarium in the classroom, it is suggested that the hermit crabs be placed separately in bowls for the children to observe at their desks before Chapter 1 is read to them. The slides pertinent to this chapter may be shown at this time.

Read Chapter 1 to the students. The students will learn about the following: DIATOMS, PLANKTON.

After reading the chapter, ask the following suggested questions:

FROM WHAT I JUST READ, HOW DID PAGOO FEED HIMSELF?
HOW BIG WAS HE?
WHAT DID HE CALL HIS "INSTINCT"?
WHAT DID HE EAT?
WHAT ARE DIATOMS?
WHAT IS PLANKTON?

Pass out copies of #2 Plankton, explain each figure. Ask students to list characteristics of the organisms shown. Begin "binding" process. It is also suggested that the students draw an environment around the baby hermit crab which they colored during their first activity. They might add water, algae and plankton.

Day 2: Chapter 2 -- "Shifting Tides and Changing Hides," pp.12-15.

Materials: Master #3 (Water Fleas)

Procedure: Pass out copies of the water fleas. Ask questions about the figures before you read. These questions may be similar to the ones asked about the hermit crab. This activity may be done in the morning along with their other seat work.

The second step may be done in the afternoon or immediately after step one. Read Chapter 2. After reading the chapter, ask the following questions:

FROM WHAT I JUST READ, WHAT DID YOU LEARN ABOUT TIDE POOLS?

HOW MAY HOURS DOES EACH HIGH TIDE AND LOW TIDE LAST?

You may wish to ask questions about their new vocabulary words described in this chapter: COPEPODS, SAND HOPPERS, TIDE POOL, CRUSTACEAN, NOCTILUCA. Tell them that the figures from their first activity were called water fleas.

Day 3: Chapter 3 -- "Pagoo Is A Hermit Crab!" pp. 16-19.

Materials: Master #4 (A-Crawfish, B-Hermit Crab)

Procedure: Pass out copies of the crawfish and hermit crab. Discuss the similarities and differences between the two figures. Ask which one would be the hermit crab and tell them that the other is called a crawfish. Have students list characteristics.

Read Chapter 3 Then ask:

WHAT DID PAGOO'S FEATHERY FINGERS TURN INTO?
WHY IS A HERMIT CRAB CALLED A "HERMIT?
WHAT MADE PAGOO UNHAPPY ABOUT HIS NEW BODY?
HOW DID PAGOO FEEL ABOUT HIS TAIL?
WHAT DID OLD PAL TELL PAGOO TO DO WITH HIS NEW SOFT TAIL?

Day 4: Chapter 4 -- "At the Ringside," pp. 20-23.

Materials: No master for this chapter.

Procedure: By now you have become familiar with introducing the various animals and vocabulary to your students. Continue in the manner to which they respond best.

New vocabularies and masters to use will be listed for each day until the book has been completed.

Vocabulary: SNAILS

Discovery Facts: HOW PAGOO BREATHES; HOW PAGOO EATS USING HIS NEW CLAWS.

Day 5: Chapter 5 -- "A Ride and a Fall Far, Far From Home," pp. 24-27.

Materials: Master #5 (Mussels)

Vocabulary: MUSSEL SHELLS, BARNACLES, SEA ANEMONE, MOLLUSK, BIVALVE, UNIVALVE, BYSSUS.

Discovery Fast: CRUSTACEANS GROW BACK WHAT HAS BEEN BROKEN OFF.

Day 6: Chapter 6 -- "A Starfish and a Few Barnacles," pp.28-31.

Materials: Master #6 (A-Flatworm, B-Barnacle Nauplius Larva, C-Barnacle Cypris Larva, D-Adult Barnacle)

Vocabulary: FLATWORM, STARFISH, GOOSE BARNACLE, OTHER BARNACLES.

Discovery Fact: HOW BARNACLES LIVE.

Day 7: Chapter 7 -- "Room and Board, Travel Included," pp. 32-35.

Materials: No master for this chapter; however, a review with slides of organisms the students have learned up to this time is recommended.

Vocabulary: HERRING, SMOOTH-TURBAN SHELL.

Day 8: Chapter 8 -- "Around Snail Cousins' Rock," pp. 36-39.

Materials: Master #7 (A-Abalone, B-Limpet, C-Sea Hare)

Vocabulary: ABALONE, LIMPET, SEA SLUG, SEA HARE, RADULA.

Discovery Fact: HOW SNAILS EAT.

7

Day 9: Chapter 9 -- "In, Out, Up with Travelling Towers," pp. 40-43.

Materials: Master #8 (Sculpin) and #9 (A-Gull, B-Sandpiper, C-Curley)

Vocabulary: SCULPIN, CURLEY, SANDPIPER, GULL.

Discovery Fact: HOW GULLS EAT.

Day 10: Chapter 10 -- "Houses Are Scarce in Tide-Pool Town," pp. 44-47.

Materials: Master #10 (A-Sea Urchin, B-Sand Dollar, C-Sea Star)

Vocabulary: SEA URCHINS, SAND DOLLAR, SEA STAR.

Day 11: Chapter 11 -- "A Concrete Tile Can Crawl Both Ways," pp. 48-51.

Materials: Master #11 (Tube Snail Shell)

Vocabulary: TUBE SNAIL, HORN SHELL.

Day 12: Chapter 12 -- "Hermit House From An Ancient Jungle," pp. 52-55.

Materials: Master #12 (A-Chiton, B-Brittle Star, C-Sea Cucumbers)

Vocabulary: CHITON, SEA ANEMONE, BRITTLE STAR, SEA CUCUMBERS.

Day 13: Chapter 13 -- "The Grotto of Eating Trees," pp.56-59.

Materials: Master #13 (A-Bryozoan, B-Jellyfish Polypoid Stage, C-Hydroid)

Vocabulary: HYDROID, BRYOZOAN, PERIWINKLE SHELL.

Day 14: Chapter 14 -- "Among the Crabs, A Shy, Masked Lady," pp. 60-63.

Materials: Master #14 (A-Decorator Crab--Bare, B-Decorator Crab--Dressed)

Day 15: Chapter 15 -- "Pagoo Takes A Shell--Keeps It, Too," pp. 64-67.

Materials: Master #15 (A-Hermit crab with Shell, B-Hermit Crab without Shell).

Vocabulary: BROWN TURBAN SHELL (review)

Discovery Fact: HOW HERMIT CRABS KEEP THEIR HOMES.

Day 16: Chapter 16 -- "Death Trap!" pp.68-71.

Vocabulary: WILD GEESE, LIMPET (review).

Discovery Fact: WHAT PURPOSE PAGOO'S TWO SETS OF FEELERS HAVE AND WHY RAIN WILL KILL A HERMIT CRAB.

Day 17: Chapter 17 -- "A Fright, a Frolic, and a Farewell," pp. 72-75.

Vocabulary: UNDERTOW.

**The children may enjoy drawing the "battle" between the "shell-less" Pagoo and the other hermit crabs.

Day 18: Chapter 18 -- "Down to the Depths of Deep Hole," pp.76-79.

Materials: Master #16 (Octopus)

Vocabulary: MORAY EEL, OCTOPUS.

Discovery Fact: THE RELATIONSHIP BETWEEN OCTOPUSES AND HERMITS.

Day 19: Chapter 19 -- "Can This Be the End of Pagoo?" pp. 80-83.

Vocabulary: TENTACLE

Discovery Fact: WHAT AN OCTOPUS DOES IN THE TIME OF TROUBLE.

**The children may enjoy predicting the outcome of Pagoo's dilema.

Day 20: Chapter 20 -- "Endless Rhythm of An Old, Old Sea," pp. 84-87.

Materials: Master #1 (Larval Hermit Crab)

Discovery Fact: HOW HERMIT CRABS MATE.

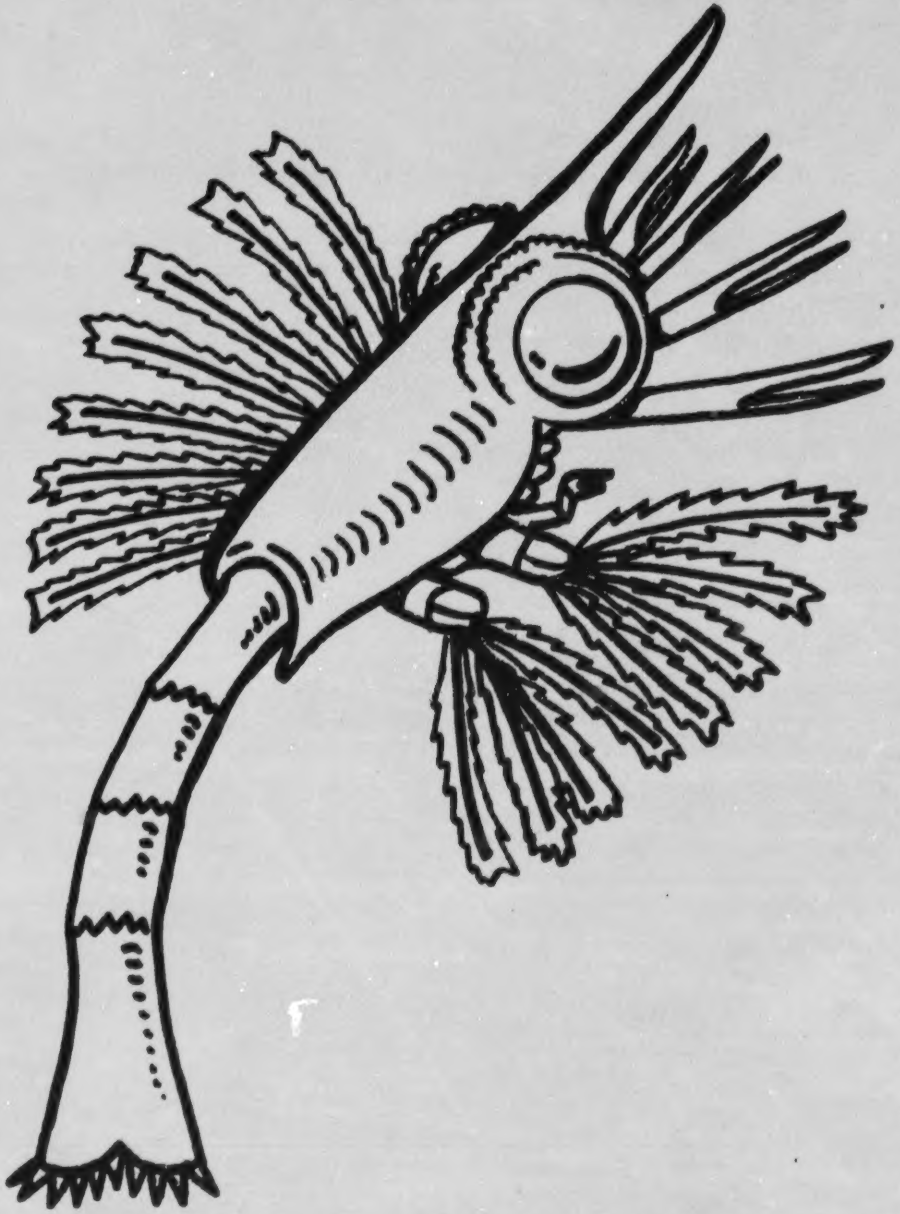
ADDITIONAL ACTIVITY

"Story of a Book," a sound film by Churchill Films, tells how the book Pagoo was made. Its purpose is to teach children the steps followed in making a book--from the idea for a book to its printing. The film includes activities. The same information is avialable on a filmstrip and record by Pied Piper, copyright MCMLXX, called "Story of a Book." Consult your film sources for more information.

MAGAZINE SOURCES OF PICTURES OF MARINE ORGANISMS

The following National Geographic magazines contain pictures of animals mentioned in Pagoo:

1. Amos, William H. 1965 "The Living Sand" Vol. 127 (6).
   WATER FLEA: p.829.
2. Clark, Eugenie. 1972. "The Red Sea's Gardens of Eels" Vol. 142 (5). pp. 724-35.
3. Hitchcock, Stephen W. 1973. "Can We Save Our Salt Marshes?" Vol. 141 (6).
   PERIWINKLE: p. 732
   PURPLE MARSH CRAB, FIDDLER CRAB, RIBBED MUSSEL, HERON, MARSH PERIWINKLE, SANDPIPER, OYSTER, MULLET: p. 738
   BARNACLES, MUSSELS, PERIWINKLE: p. 743
   SAND SHRIMP: p. 744
   ALGAE: p. 748
   MUSSELS: p. 750
   FIDDLER CRAB: p. 756 .
4. Marden, Luis. 1973. "The American Lobster, Delectable Cannibal" Vol. 143 (4). pp. 462-487.
5. Sugar, James A. 1970. "Starfish Threaten Pacific Reefs" Vol. 137 (3). p. 350.
6. Voss, Gilbert L. "Shy Monster, the Octopus" 1971. Vol. 140 (6). pp. 776-799.



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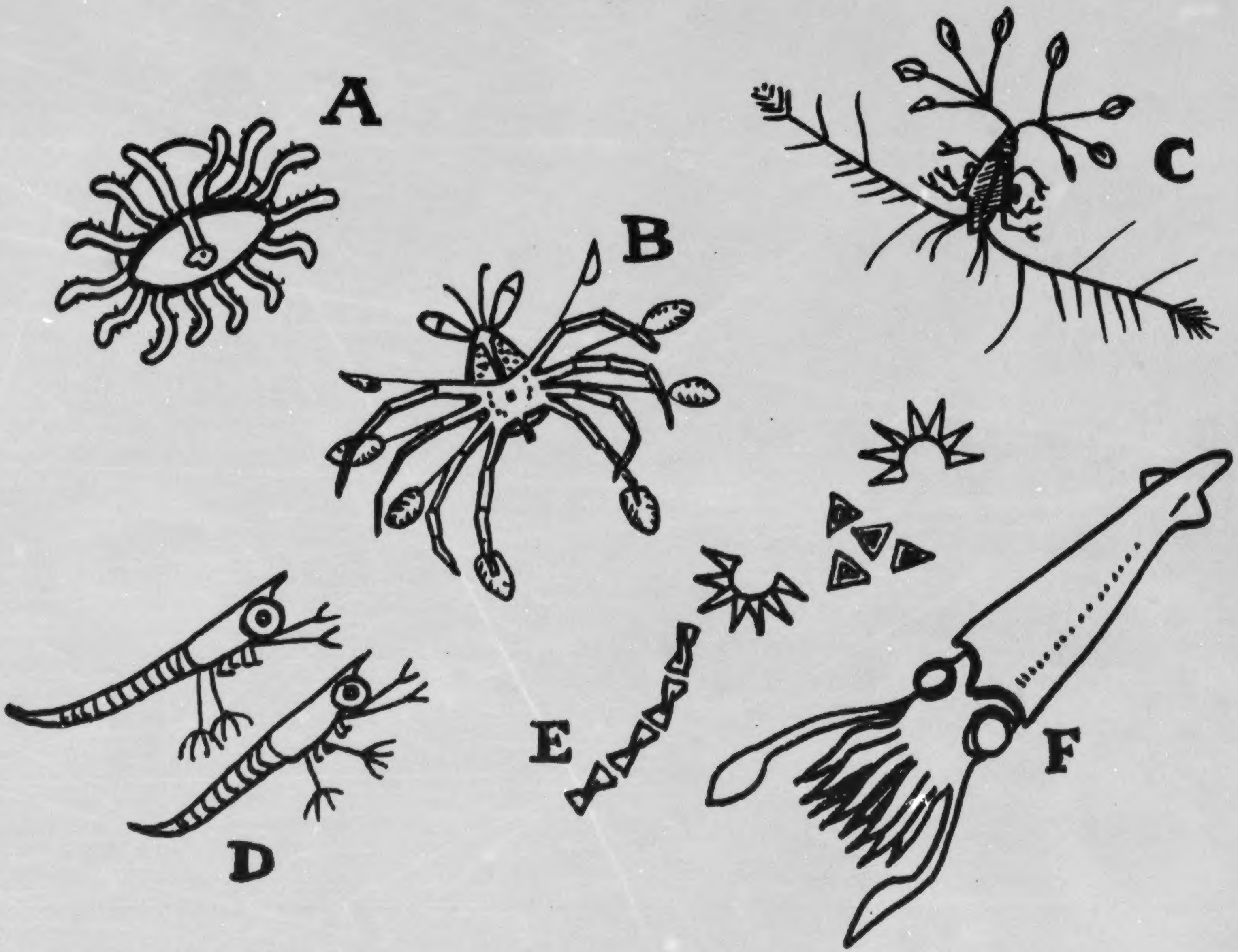

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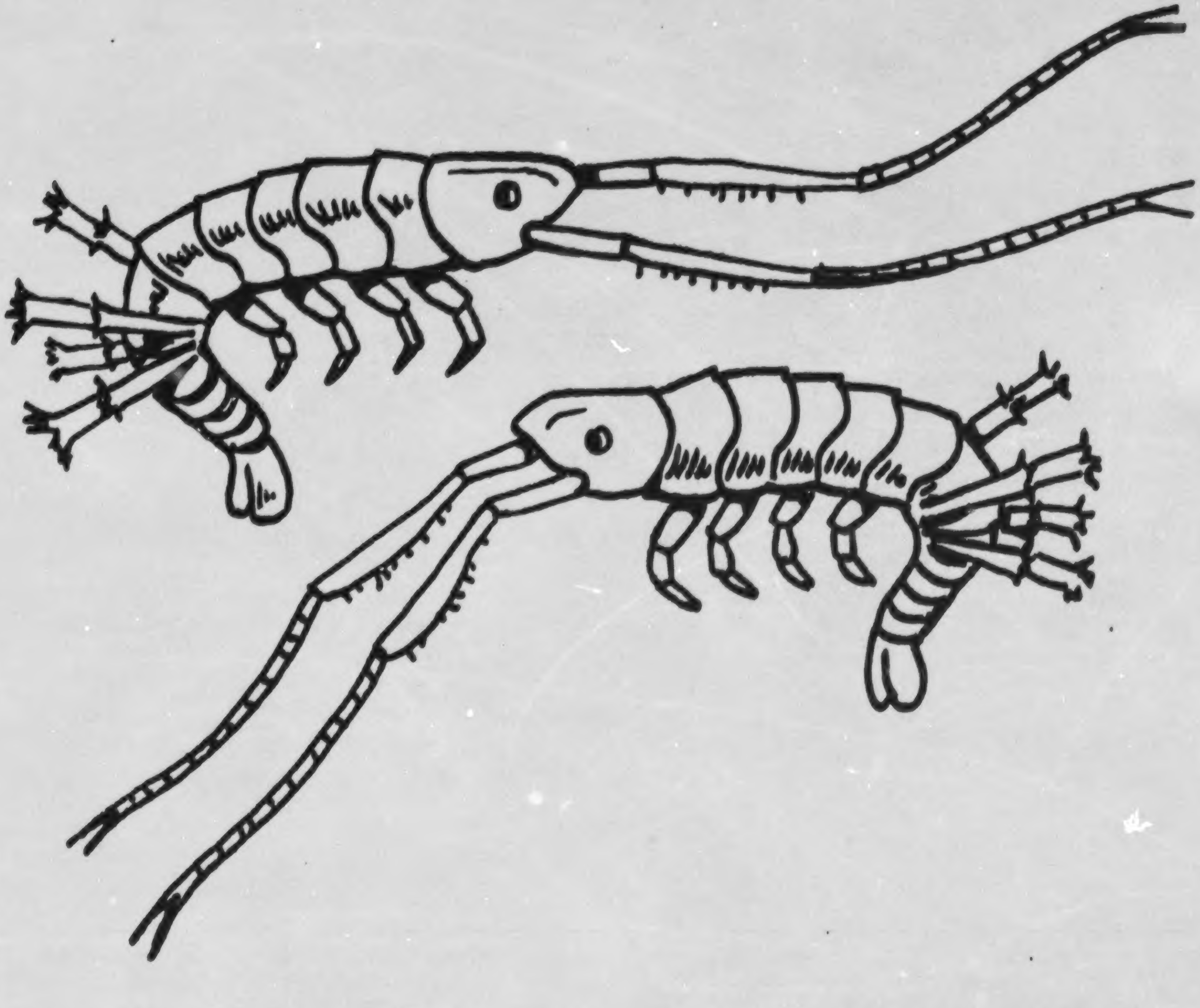

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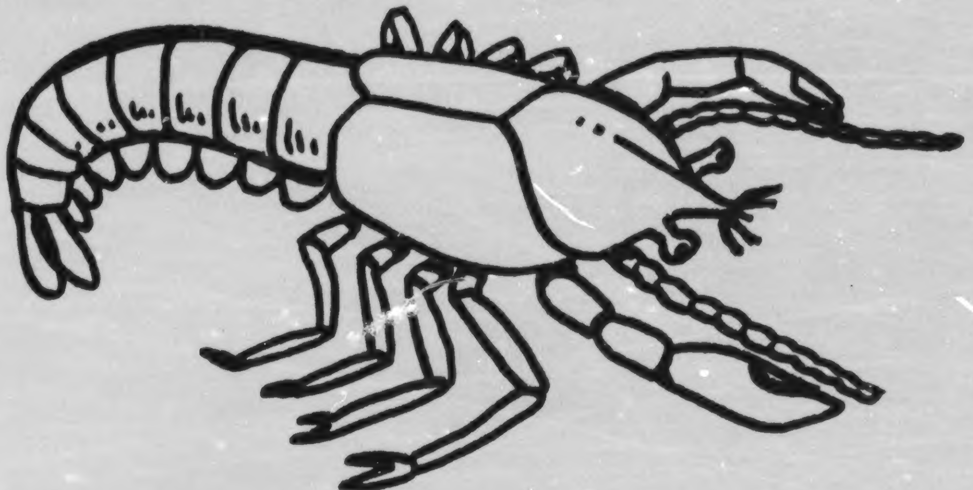

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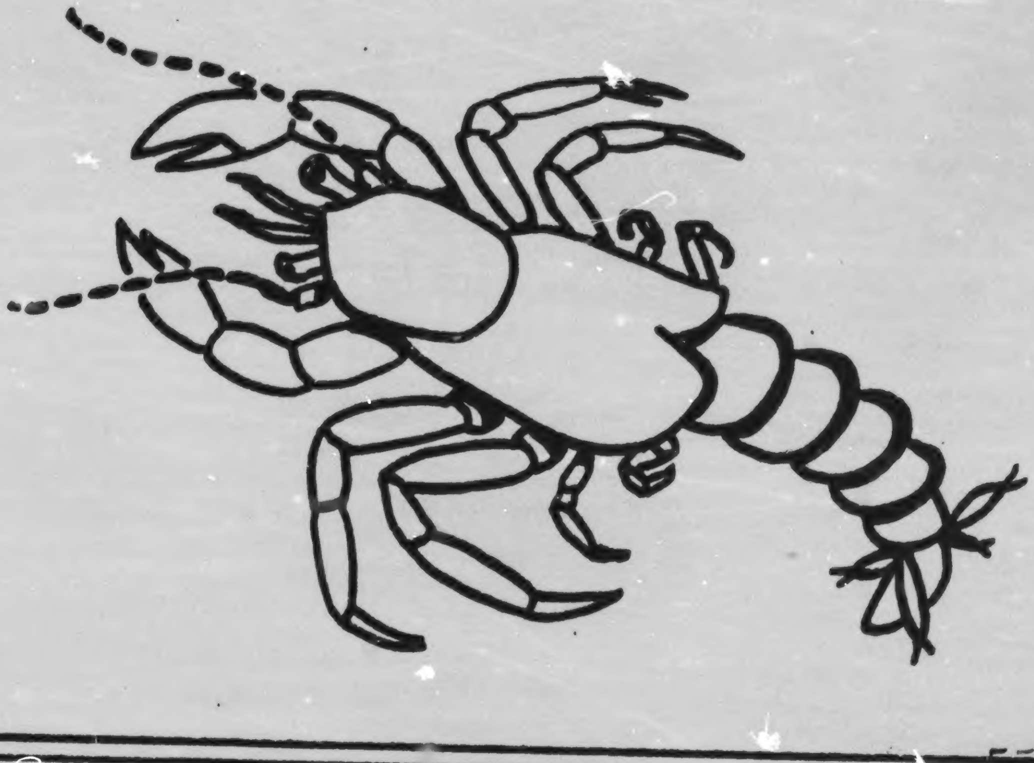

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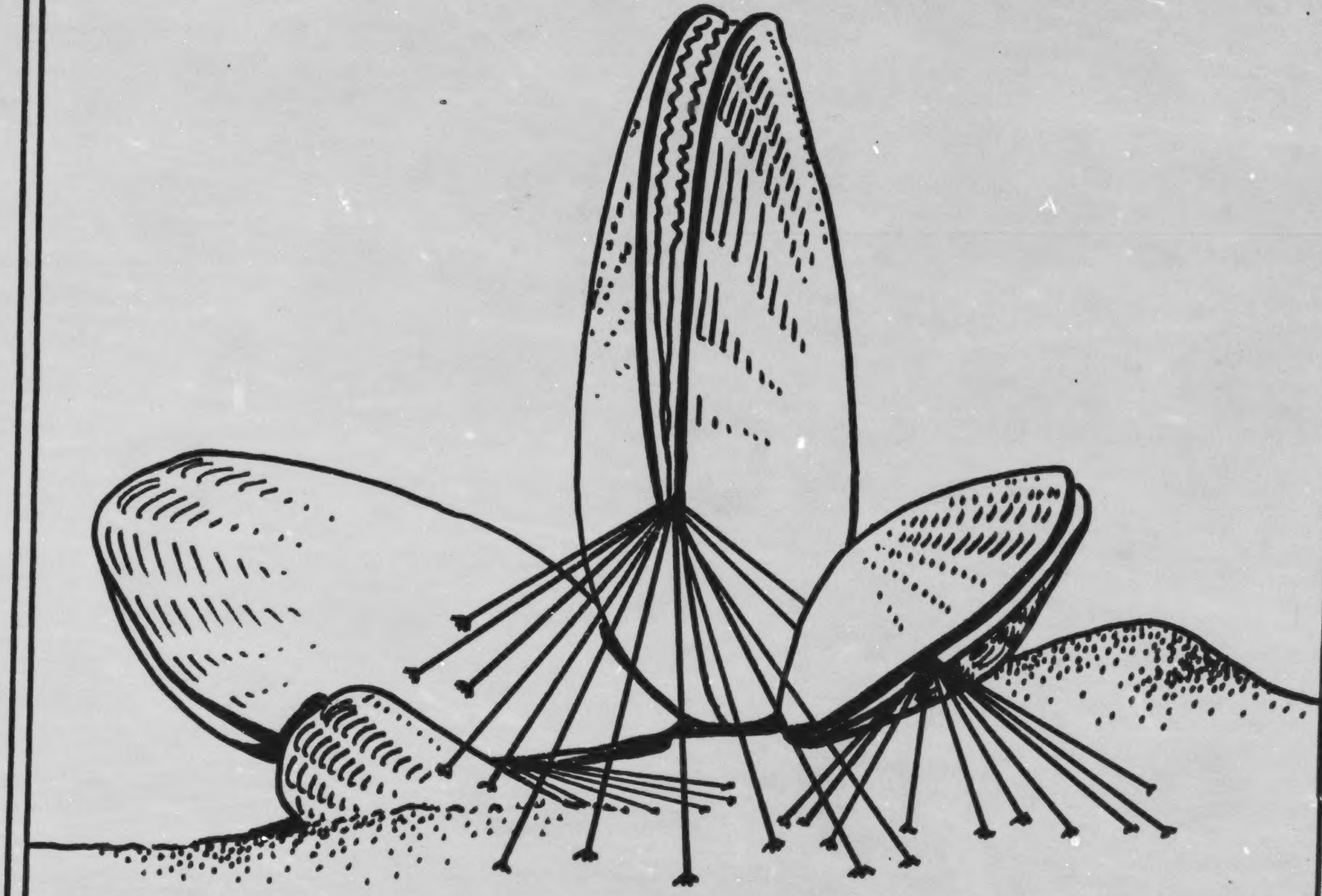

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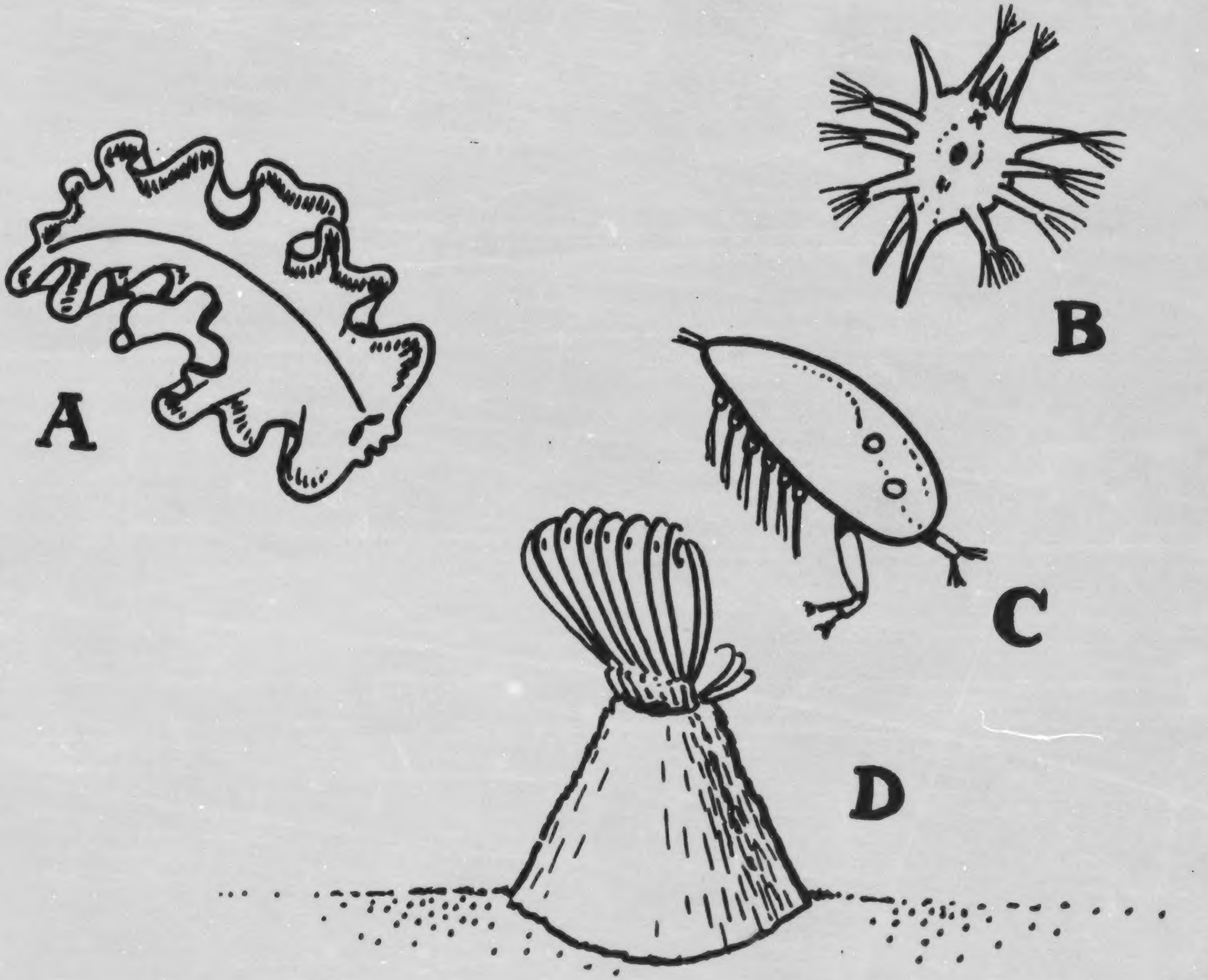

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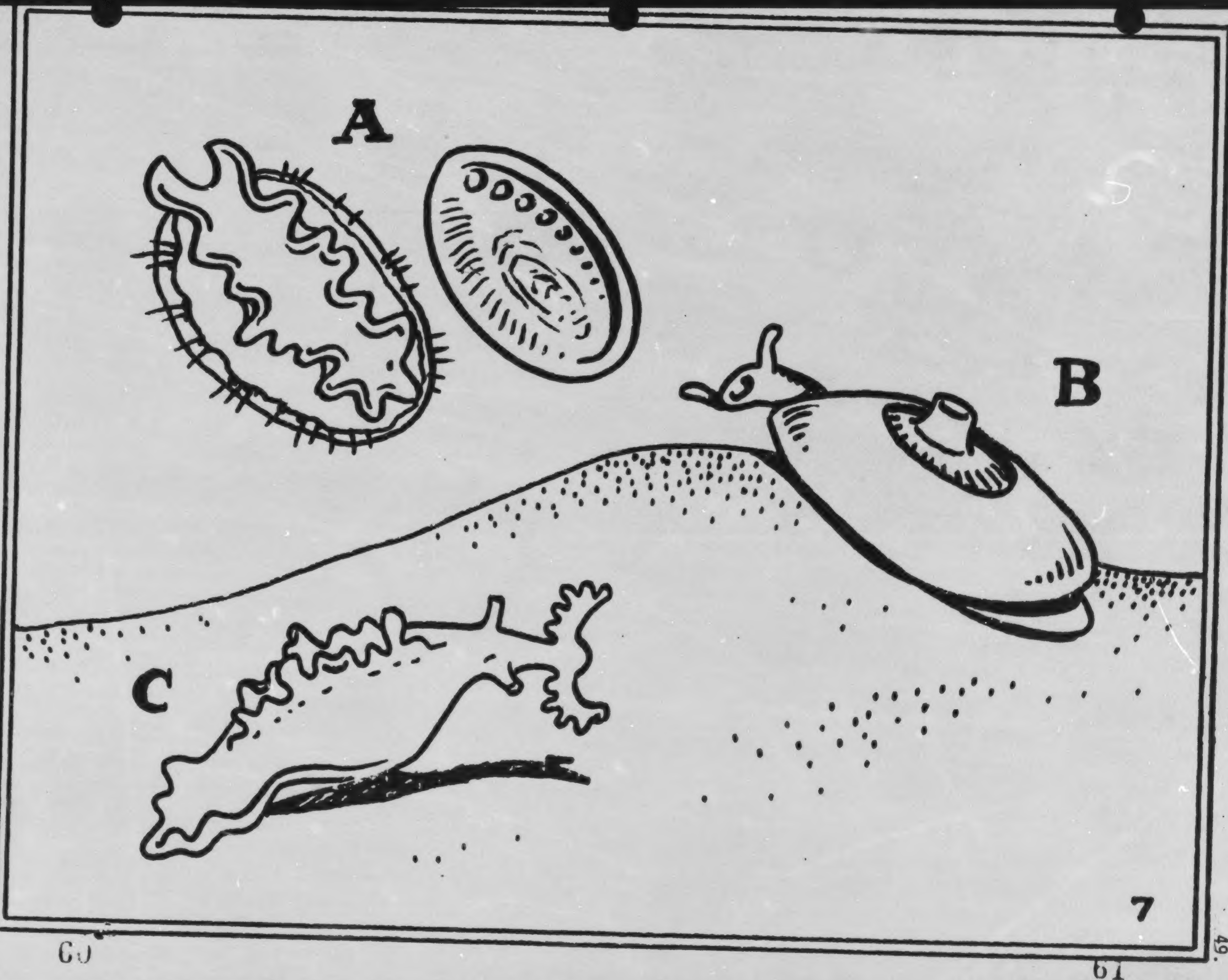
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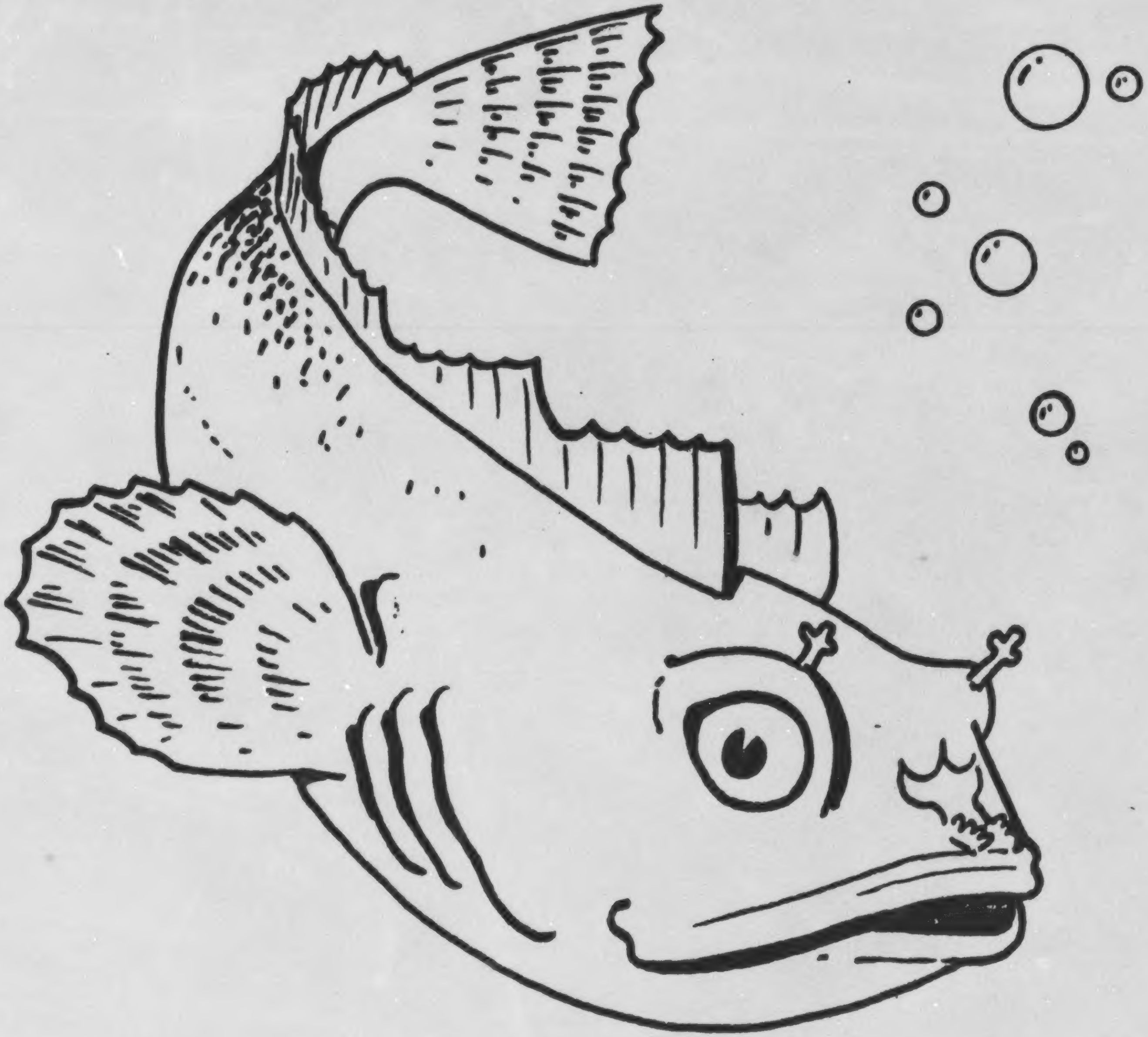

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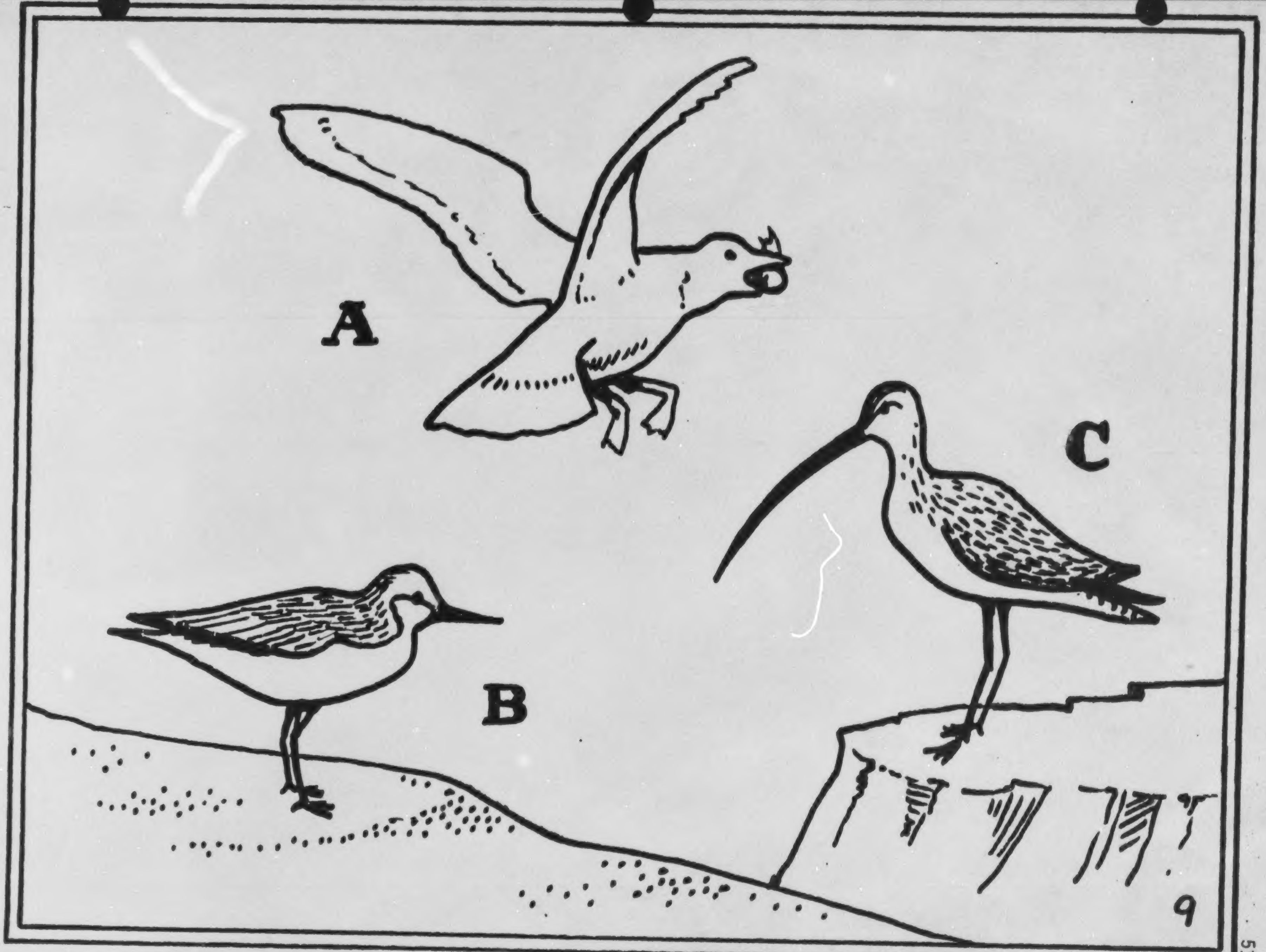
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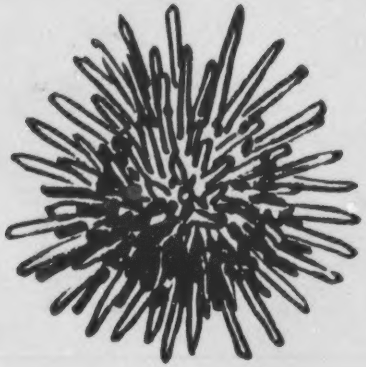

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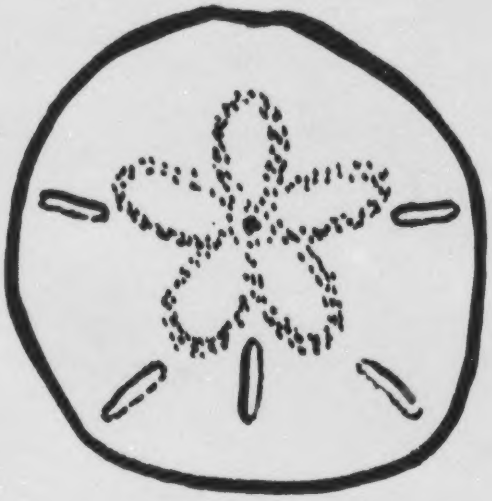

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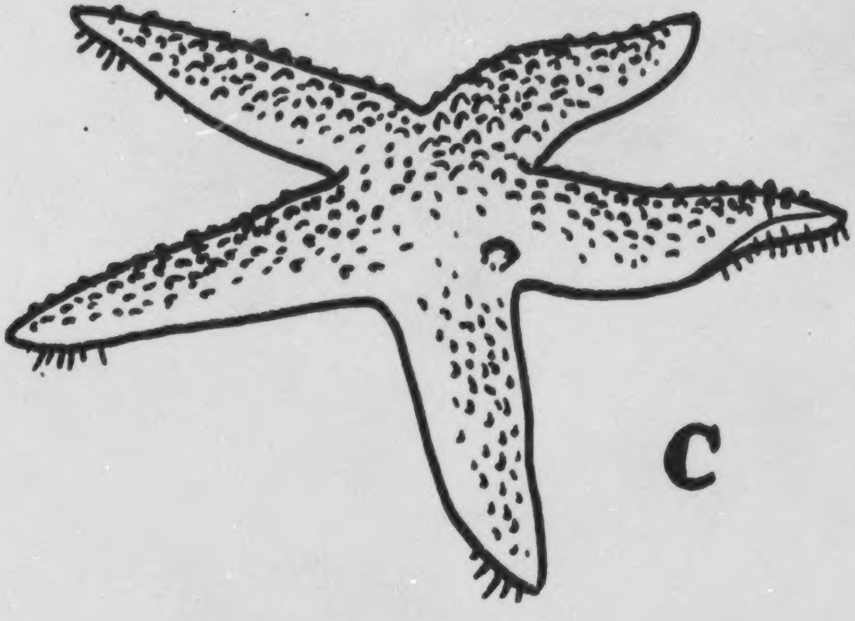

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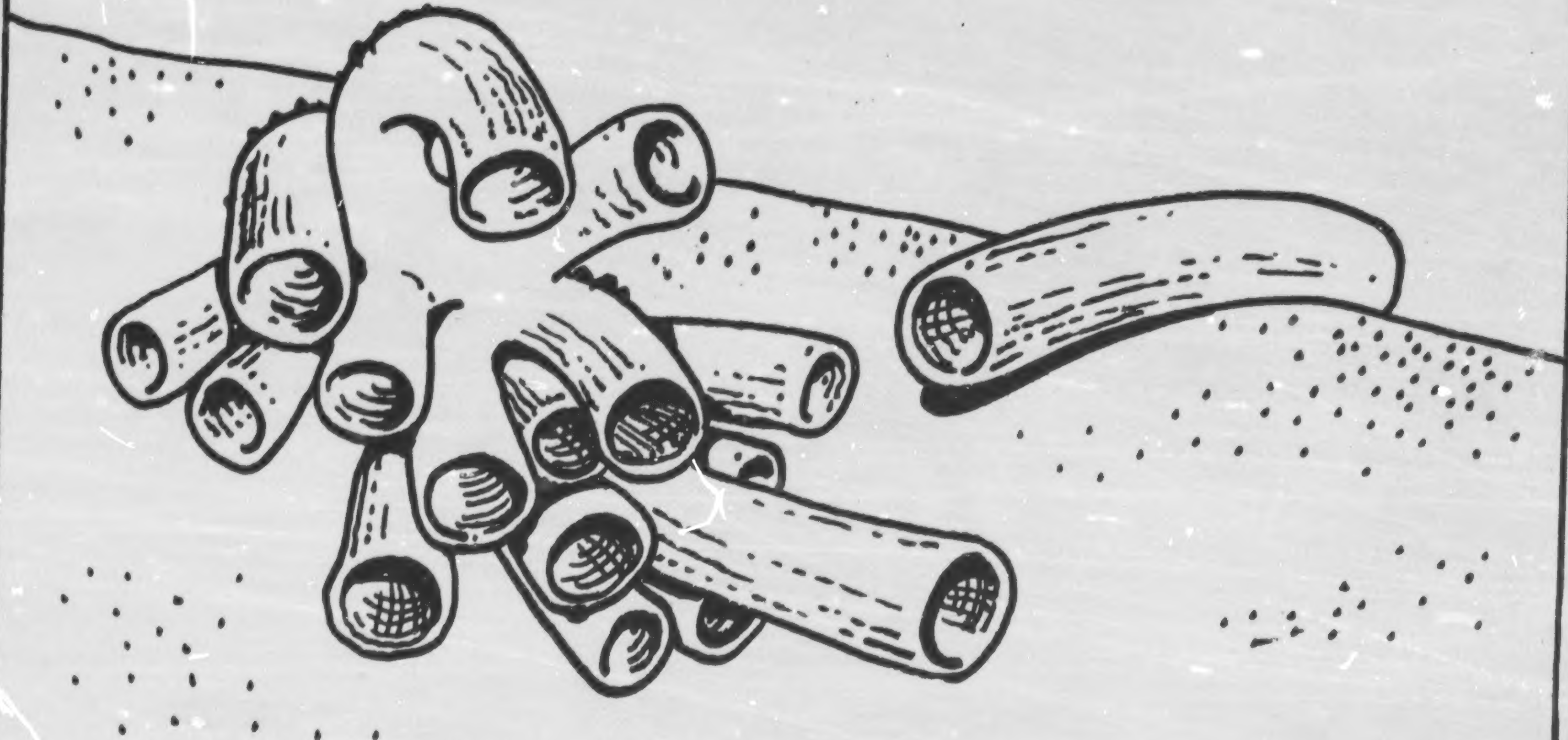

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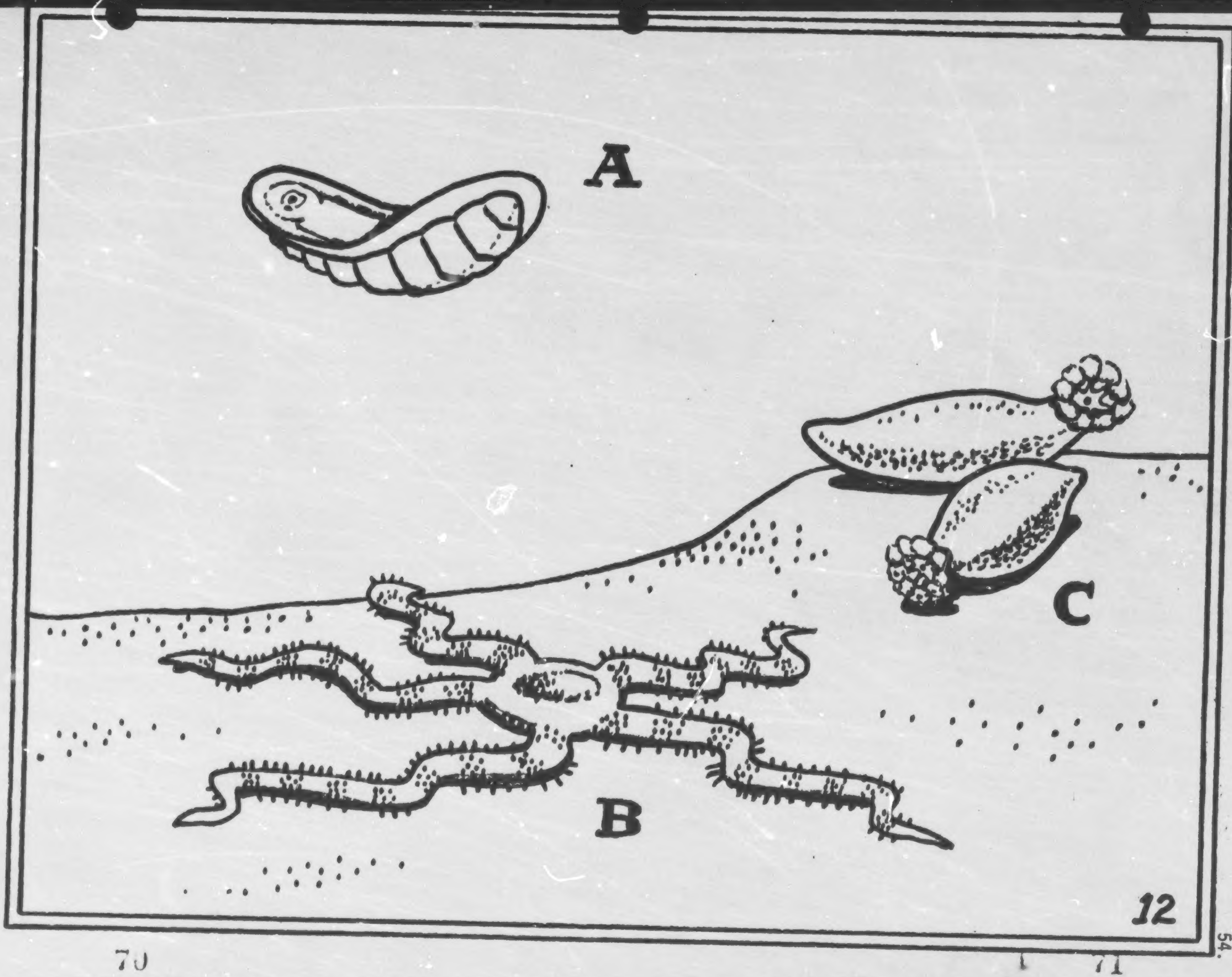

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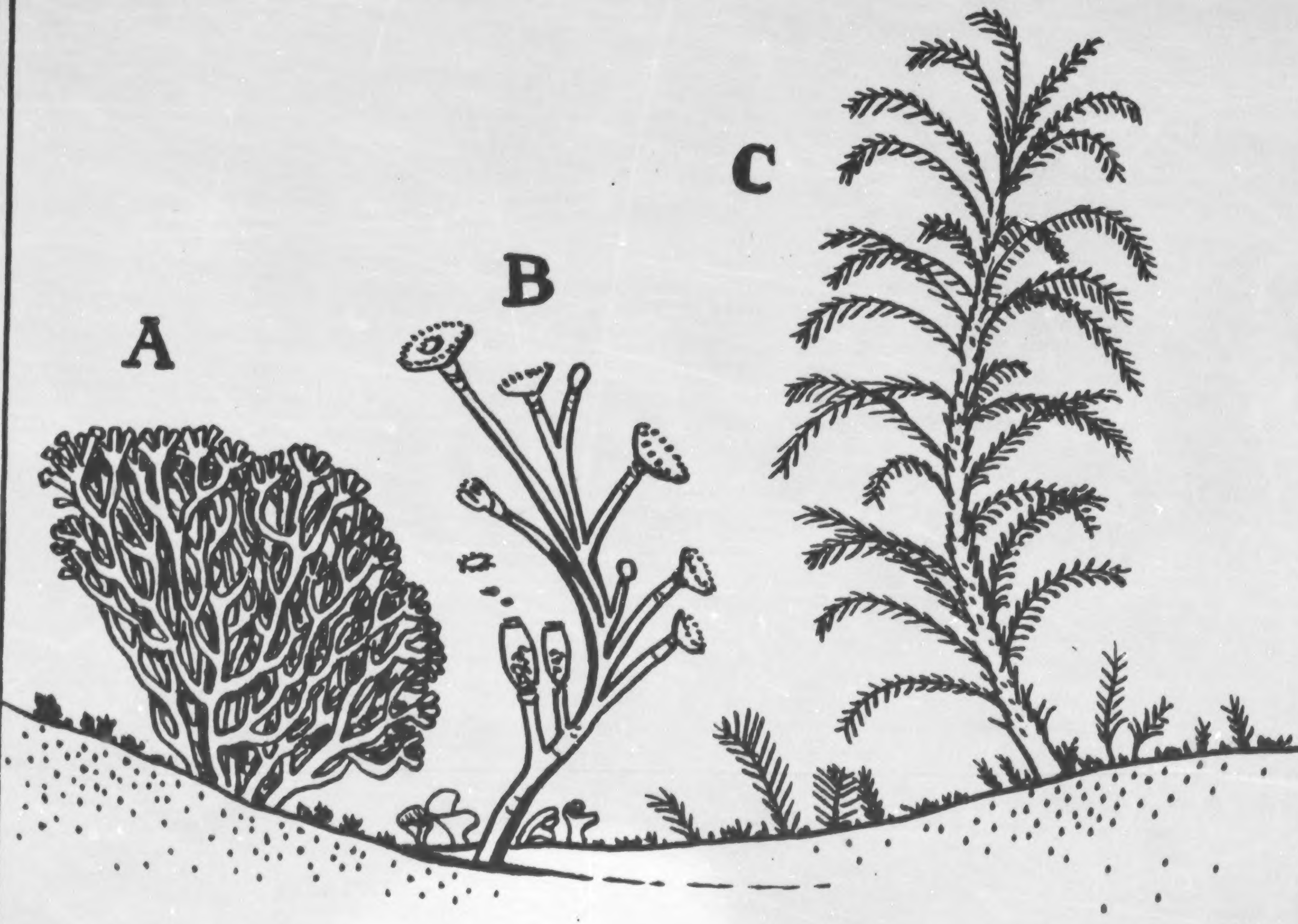

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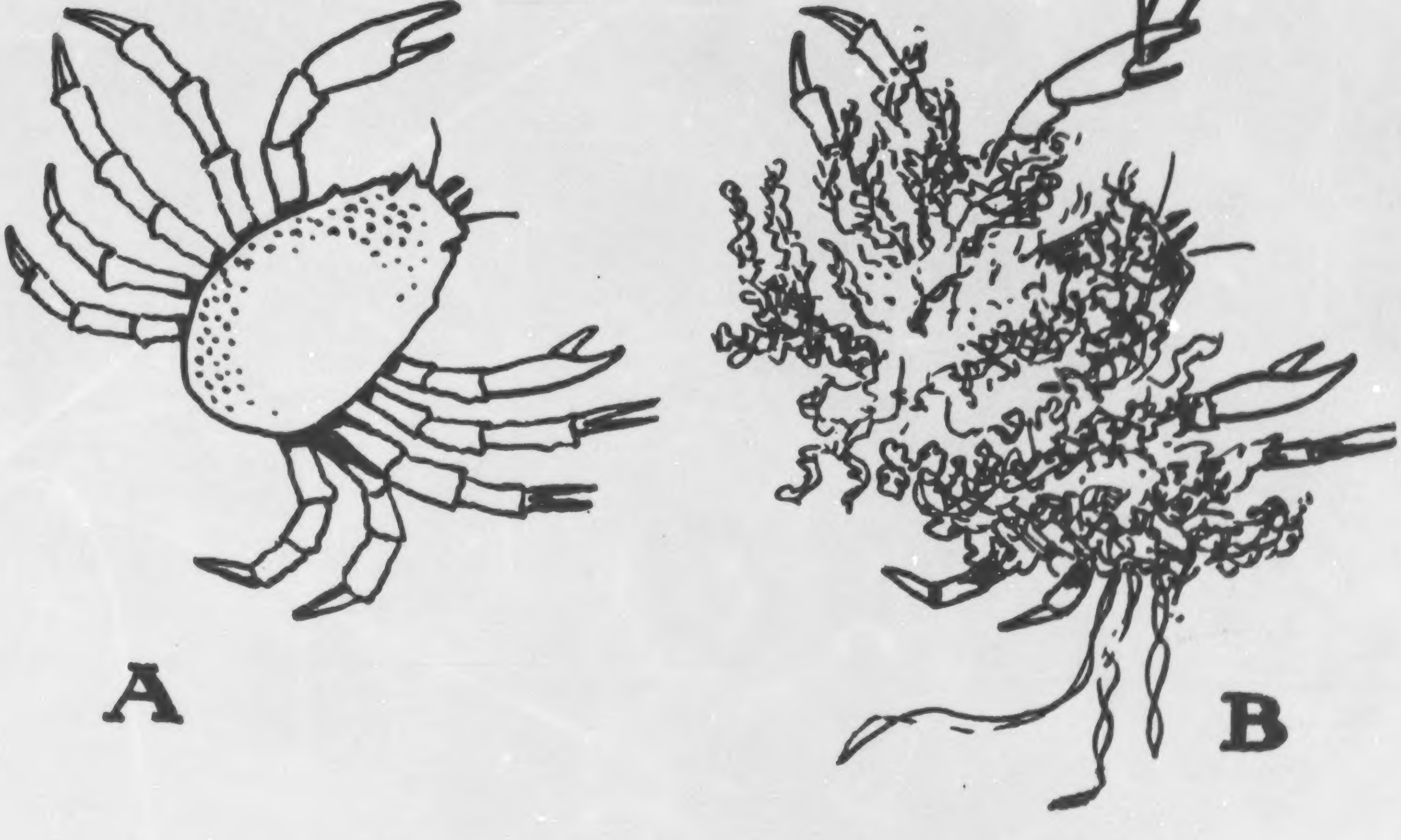

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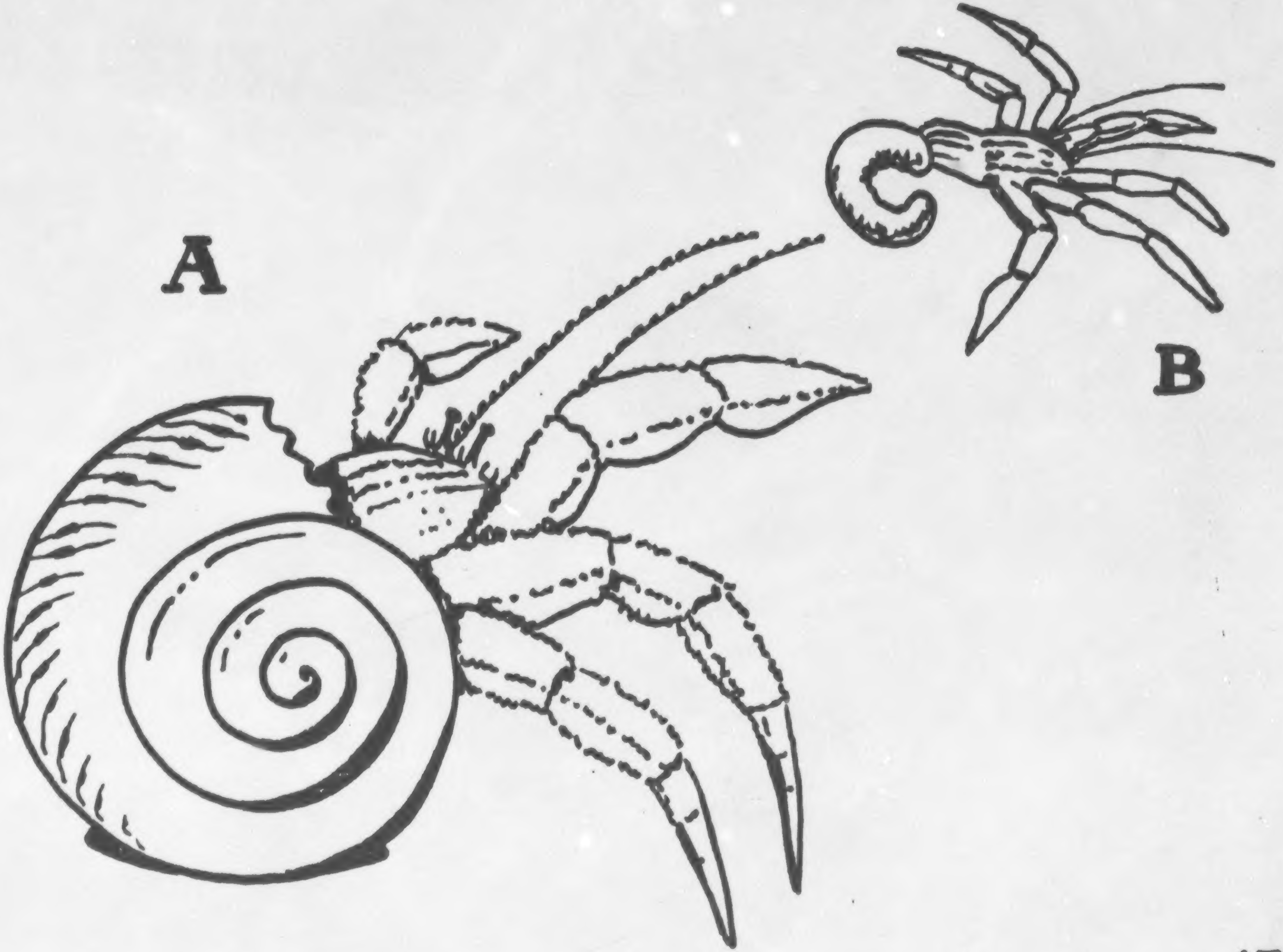

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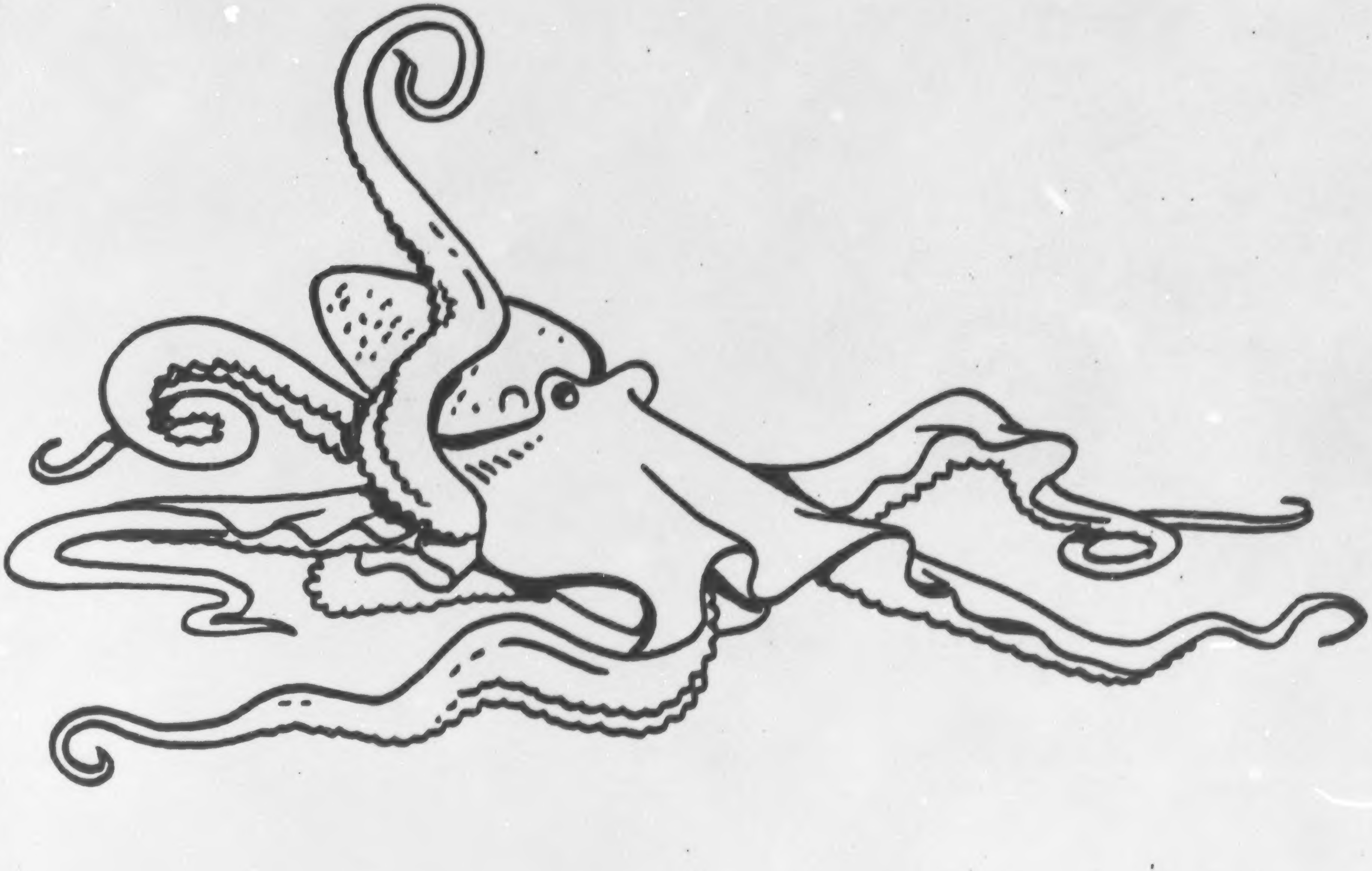

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58.

The following is a list of slides included for this activity:

Use these slides to enrich your study of Pagoo.

43. Lady Crab
44. Hermit Crab
45. Blue Mussels
46. Rock Crab on Blue Mussels
47. Sea Star (starfish)
48. Blue Crab
49. Sea Lettuce
50. Great Blue Heron
51. Sculpin
52. Jacknife (razor shell clam)
53. Sponge
54. Sea Urchin
55. Oyster
56. Sandpiper
57. Scallop shell with Sea Lettuce and Red Algae
58. Sea Cucumber (with tentacles)
59. Sea Cucumber (being held)

INTRODUCTION TO MARINE ENVIRONMENTS

81

TEACHER BACKGROUND - Introduction to Marine Environments

This section serves as an introduction to the entire unit. It is important to use all of the assets at your command to generate and foster enthusiasm for the coming events. Emphasize that both living and non-living factors influence every living creature. It is not necessary to cite myriad examples at this stage. The activities and lessons that follow will provide material to show how the living and non-living combine to form an organism environment. Keep this central theme in mind as you go through the next several weeks of instruction.

Marine studies are inherently interesting to students. They can also be fun to teach. Enjoy this experience and your students will also.

PROCEDURE

1. Duplicate the text and crossword puzzle.
2. Have students read "Introduction to Marine Environments" and answer questions as they read.
3. In a class discussion, summarize the section and answer the six questions from the text.

KEY - Questions from Introduction to Marine Environments

1. There are many possible answers. For example, the material of which the bottom is composed, pressure of water, pounding from the surf, etc.
2. Again there are many possible answers. For example, sea gulls that might eat the sea star, people turning the sea star over and not returning it, etc. Questions 1 and 2 can provide material for discussion.
3. Space in which to live, food, water and air.
4. The answers will vary widely. Logic should prevail.
5. Same as question 4.
6. Man tends to simplify environments.

This section provides ample opportunity for discussion. The challenge is to regard this as an introduction and not to get deeply involved, at this point, in the topics mentioned. You will have lots of chances to elaborate on these concepts.

KEY WORDS

air

aquatic

ecology

environment

food

living

organism

non-living

parasites

space

terrestrial

water

INTRODUCTION TO MARINE ENVIRONMENTS

What is an environment? An environment is all of the things that surround and affect a living creature. Ecology is the study of these environments. What kinds of things make up an organism's environment? Let's look at a sea star (starfish) and see. What kinds of non-living things affect the sea star? Temperature of the water and the air, movement of the water, and the chemicals present in the water, are all non-living things that affect the sea star.

1. Name one other non-living thing that might affect the sea star.____

There are also many living things that affect the sea star and are therefore a part of its environment. The amount and kind of food present, and parasites that live on the sea star, are living things that affect our sea star.

2. Name one other living thing that might affect the sea star.

____

What are some of the qualities an environment must provide before life can exist? Animals (any living thing which is not a plant! require:

a. Space in which to live
b. Food
c. Water
d. Air

These factors must occur in an adequate amount and in the proper location for the animal. Plants also require these four items.

In addition, green plants require sunlight.

3. Deer live in the forest. What four items must the forest provide for the deer?

   a.________________________

   b.________________________

   c.________________________

   d.________________________

What kinds of environments exist? We can look first at the land or terrestrial environments. We might make the following list of terrestrial environments:

1. Wooded
2. Grass lands
3. Tundra
4. Mountainous
5. Desert
6. City
7. Country

Each of these environments has different animals and plants. Animals and plants find the things that they require for life within their environments.

4. For four of the terrestrial environments listed, name an animal or plant you would expect to find in that environment. Write the name next to the environments listed above.

Just as there are many kinds of land based environments, there are also many kinds of water based or aquatic environments. We could again make a list like the following:

1. Swamp
2. Lake
3. River and Stream
4. Estuary (fresh and salt)
5. Seawater
6. Aquariums

These environments each provide space, food, water and air for certain kinds of plants and animals.

5. For four of the aquatic environments listed, name an animal or plant that you would expect to find in that environment.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

What is the effect of man on these environments? Man is an agent of change. This means that man tends to change the environments around him. We tend to make environments more simple. We eliminate certain animals and plants. We change the non-living factors by building dams, adding chemicals and heat to the water, and similar things. In the long run, simple environments may not be able to support life as we now know it. In your study of the Marine Environment look for the living and non-living factors that make up the marine environment. Look also for the impact of man on the marine environment.

6. How does man tend to change environments?____________________

____

The marine environment is one of our last frontiers. You will have a chance to discover some of the interesting things we now know about the seas. You will also see some of the things that are awaiting discovery. Perhaps you will be the person who will someday answer the questions we have about the marine environment. The marine environment will play.an important role in the future of this country and of the world. Understand and enjoy the marine environment.

TEACHER BACKGROUND - Marine Environments Crossword

This crossword is designed to build vocabulary skills by reinforcing the words introduced in the reading section.

PROCEDURE:

Duplicate a crossword puzzle blank and a clue page for each student.

You may elect to have students work on this puzzle individually or in small groups. Alternatively, you can have them work for a set period of time independently, then have them form groups to share answers and finish the puzzles. Each approach has its merits. The one chosen will depend upon your class. Regardless of the approach, you should plan to spend a few minutes at the end of the exercise in review. Give the correct answers (or better yet, have the students give the correct answers).

Some students seem to excell in making crossword puzzles. You should think about providing graph paper and encouraging students who wish to do so to make crossword puzzles about any of the topics covered. These puzzles can be fun and you can use them to help other students reinforce areas in which they might be having difficulty.

TEACHER BACKGROUND

Marine Environments Key

				2. L		3. T		4. M				7. F
				I		E		A				U
		1. E	N	V	I	R	O	N	M	E	N	T
		C		I		R						U
		O		N		E						R
		L		G		9. S	P	5. A	C	E		E
8. F	O	O	D			T		I				
		G				R		R		6. W		
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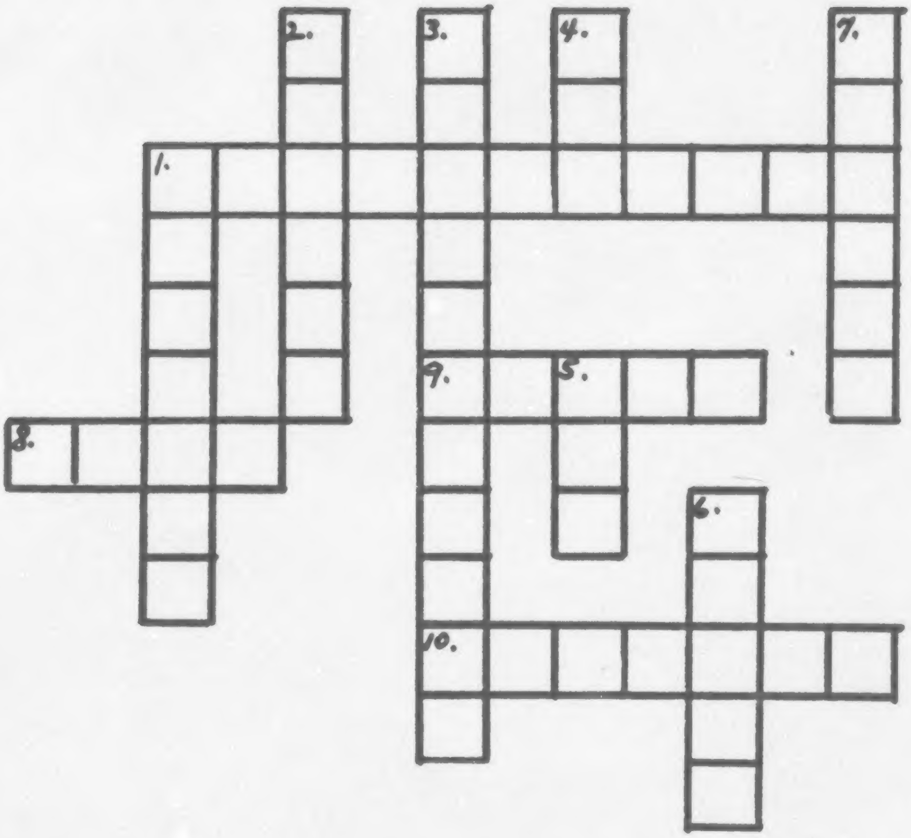
MARINE ENVIRONMENTS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MARINE ENVIRONMENTS

Down:

1. The study of environments.
2. An organism's environment is composed of both the non-living and the ___________ things that affect that organism.
3. Land environments are said to be _______________.
4. An agent of change.
5. One of the qualities an environment must provide before life can exist.
6. One of the qualities an environment must provide before life can exist.
7. The oceans will play an important role in our __________.

Across:

1. All of the living things that surround and affect a living creature.
8. One of the qualities an environment must provide before life can exist.
9. One of the qualities an environment must provide before life can exist.
10. Water based environments are called _____________.

SALT WATER ENVIRONMENT

92

TEACHER BACKGROUND - Salt Water Environment

This section investigates the salt water environment introduced in the "Introduction to Marine Environment." The section consists of four activities, each of which has a separate TEACHER BACKGROUND section. The emphasis in this section is on the unique features of the marine environment. Relate the non-living and living aspects of the environment to specific organisms.

Salt water basically differs from fresh water by the salt dissolved in it. This salt is sodium chloride, commonly known as table salt.

Salinity has been defined as the saltiness in the ocean. Salinity is designated by the symbol o/oo, which means the number of dissolved salts per one thousand parts of water. Your students may understand this designation more readily if you relate parts per thousand (o/oo) to percent which is parts per hundred (o/o). The two differ by a factor of ten which is reflected by the extra "o" in parts per thousand. Our local sea water generally ranges from 25 to 34 parts of salt per thousand parts of water (25 o/oo to 34 o/oo.)

Each specific area in the ocean has its own salinity range. The salinity will give the oceanographer a clue to the age of the water in that particular area. The higher the salinity the older the water. It also tells the scientist what organisms may or may not live within a given area. Salinity may therefore be considered a limiting environmental factor.

Organisms are usually divided into two basic types in regard to salinity. The first type are those that may withstand only limited changes in salinity and are called stenohaline. Those which may tolerate wide fluctuations in salinity are called euryhaline.

If a stenohaline organism migrates from an area of high salinity to one of low salinity, its body cells tend to absorb more water. If the organism moves from a low to a high salinity, the opposite would occur. Because the organism's internal and external environments must always be in balance, the resulting loss of water or gain of water would lead to the eventual death of the organism.

Currents which flow all year long are pushed along by differences in the weight and temperature of the water. Cold water is heavier than warm water and tends to sink. The heaviest water is found at the very bottom of the sea. Salt can also make water heavier. To some degree the currents are also shaped by the earth's rotation and prevailing winds.

PROCEDURE

1. What are the main differences between a fresh water environment and a salt water environment? Discussion.

   A. Chemical elements of sea water

1.	Sodium	10.56 o/oo (parts per thousand parts of water)
2.	Chloride	18.98 o/oo
3.	Magnesium	1.27 o/oo
4.	Sulphur	0.88 o/oo
5.	Calcium	0.40 o/oo
6.	Potassium	0.38 o/oo
7.	Bromine	0.065 o/oo
8.	Carbon	0.028 o/oo
Total salinity		32.5630 o/oo

NOTE: Sodium and chloride combine to make salt.

B. Depth

   1. Ocean waters reach greater depths (35,800 feet at the Mariana Trench).
   2. Plankton usually grow to a greater depth in sea water.

C. Temperature variations in sea water are greater

   1. Due to salinity variations
   2. Due to currents
   3. Due to larger bodies of water

D. Volume or size

   1. Ocean waters are greater in size.
   2. Ocean waters are greater in volume.

E. Pressures of sea water are greater

   1. Due to greater depths
   2. Due to tide and current changes

II. Activities:

   A. Water, Water Everywhere! - Composition of sea water.

   B. How Low Can You Go? - Pressure and adaptation to life at great depths.

   C. Ocean Currents - Salinity differences between two masses of water, and temperature differences between two masses of water.

   D. Density Currents in a Model Ocean - Temperature currents in a dish ocean.

III. To summarize this section: Show film Exploring the Ocean and discuss concepts of film related to:

   A. Chemical elements

   B. Temperature variations

   C. Size of oceans

   D. Depths of oceans

   E. Pressures

TEACHER BACKGROUND - Water, Water, Everywhere!

This exercise on salinity provides practice in graph reading skills. Emphasize the "universal solvent" aspect of water. Everything dissolves in water to a greater or lesser degree!

Duplicate the activity.

Students may work alone or in small groups at your discretion. After all have completed the exercise, spend a few minutes going over the answers to the questions. The process, how the answers were obtained, should be emphasized as well as the answers themselves.

KEY - Water, Water, Everywhere!

1. Chlorine has the greatest abundance (18.98 ppt)
2. Sodium has the second greatest abundance (10.56 ppt)
3. Carbon is the least abundant element shown (.028 ppt)
4. If all of the sodium and chlorine were to combine, 8.42 ppt of chlorine would remain (18.98 ppt chlorine - 10.56 ppt sodium = 8.42 ppt chlorine).
5. For the eight most common elements in sea water, the total salts ppt is 32.563 ppt (18.98 + 10.56 + 1.27 + .88 + .40 + .38 + .065 + .028 = 32.563 ppt)
6. .065 ppt x 1500 = 97.5 pounds of bromine.
7. $\frac{\text{10.56 ppt sodium + 18.98 ppt chlorine}}{\text{32.563 ppt for all salts}} \times 100 = 90.71\%$
8. .0000000004 ppt gold x 1,000,000 water = .0004 tons or .8 pounds or 12.8 ounces (at $200/oz = $2,560)

KEY WORDS

abundance

bromine

calcium

carbon

KEY WORDS (cont.)

dissolved

magnesium

parts per thousand (ppt)

percentage

potassium

salinity

sea water

sodium

sulphur

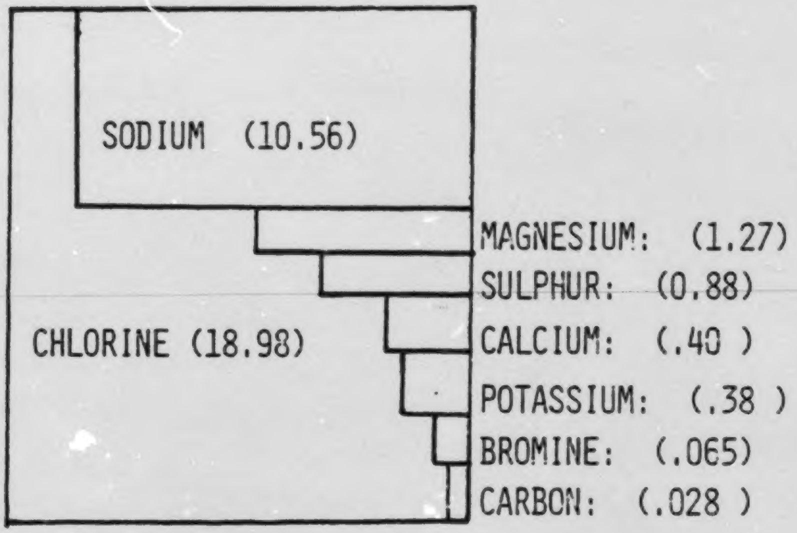
WATER, WATER EVERYWHERE!

When you stand on the beach and look at the ocean, the water you see looks like the water in a lake or stream. As soon as you run into the water you can feel and taste the difference. How does sea water differ from other waters? We call sea water "salt water" and other waters "fresh water." This gives us a clue to their differences. Salt water basically differs from fresh water by the salt dissolved in it.

The saltiness of the ocean, salinity, is measured in parts of salt per thousand parts of water. A salinity of 34 parts per thousand would have 34 parts of salt per thousand parts of water. Parts per thousand is written o/oo ppt.

The following graph shows the most common materials dissolved in salt water.

MATERIALS IN SEAWATER (o/oo)



Use the graph to answer the following questions:

1. Which element has the greatest abundance?______________________

____

2. Which element has the second greatest abundance? ______________

____

3. Which element shown on the chart is least abundant? ____________

____

4. Sodium and chlorine can combine to form table salt, sodium chloride. If all of the sodium and chlorine were to combine to form table salt, how much of which element would be left over? Please show your work.

5. For the eight most common elements in sea water, what is the total parts of salt per thousand parts of water? Please show your work.

6. How many pounds of bromine would there be in 1,500 pounds of water?

____

7. What percent of the saltiness of sea water is due to sodium and chlorine?

(HINT: to find percentage:

$$\frac{\text{sodium + chlorine o/oo}}{\text{total parts per thousand}} \times 100 = \text{\% due to sodium \& chlorine)}$$

Please show your work.

8. This graph only shows the most abundant materials in sea water. All chemical elements are found in sea water. For example, gold is found in a concentration of .0000000004 parts per thousand parts of water. How many tons of gold would you be able to mine from 1 million (1,000,000) tons of sea water?

(HINT: multiply while keeping track of the decimal points)

For an interesting account of gold mining ocean water read: "The Man Who Ploughed the Sea" in Prelude to Mars by Arthur C. Clarke. Published by Harcourt and Brace in 1965.

TEACHER BACKGROUND - How Low Can You Go?

"How Low Can You Go?" looks at some of the non-living environmental factors that deep sea fish must deal with. The exercise provides an opportunity to emphasize the idea that structure and function are closely related.

Duplicate the activity. One per student.

This activity is best accomplished on an individual basis with group or class discussion as a follow-up. If the situation demands, it is possible to do this activity in small groups. A period for discussion and review of the correct answers should be planned for the end of the exercise.

The concepts of pressure and surface area will probably be unfamiliar to your students. The English rather than the metric system of units has been used in this activity since it is likely to still be more familiar to your students. Metric equivalents are included in the discussions in the answer key below.

KEY - How Low Can You Go?

1. The force on a fish with a surface area of one square foot at a depth of 300 feet would be:

$$\frac{\text{64 pounds}}{\text{cubic foot}} \quad \text{X} \quad \text{300 feet} = \text{19,200 pounds per square foot.}$$

The concept of surface area can be demonstrated by using a sheet of paper. Hold the paper up and ask what the surfaces of the paper are. Since you can say the edges are negligible, the surfaces of interest are the front (top) and (back) bottom The area of one of these surfaces can be determined by multiplying length times width. The total surface area is the sum of the front and back areas. Next roll or fold the paper. Ask your class what the surface area is now. Has it changed? The area will be the same even if the shape is different. To find the surface area of a fish, then, you could physically take off the skin and lay it flat and measure it in the same fashion you measured the paper. In reality, we calculate the fish's surface area mathematically, but the principles are the same.

Pressure is often measured in terms of atmospheres (one atmosphere equals 14.7 pounds per square inch). For every 10 meters of depth in the ocean the pressure increases by one atmosphere. The angler fish at a depth of about 91.5 meters (300 feet) would face a pressure of about 9.15 atmospheres.

2. The pressure on the angler fish:

$$\frac{\text{64 pounds}}{\text{cubic foot}} \times \frac{\text{20,000 feet}}{1} = \text{1,280,000 pounds per square foot}$$

The angler fish at a depth of about 6,150 meters (20,000 feet) would face a pressure of a little over 615 atmospheres.

3. The outside pressure on a deep sea angler fish at one foot in depth would be 64 pounds per square foot. The outside pressure at about .3 meters (one foot) would be about .03 atmospheres.

4. If the internal pressure remained high, the fish would probably explode as it was brought to the surface.

5. The deep sea angler fish is usually black or dark gray. The dark color lets it remain hidden in spite of its light.

6. The angler fish teeth point backwards, toward the tail.

7. Once something is held in the teeth, it is very difficult for it to be lost.

8. Yes, the angler fish has eyes.

9. There are several kinds of experiments that students may suggest. Some are practical, some are not. Some possible suggestions: Mark fish (either with dye or radioactive tracers) and follow their movements by radio or visually; put an angler fish in a pressurized aquarium and watch its behavior; fish for angler fish in lighted ocean zones, etc.

Originality here should be rewarded with a kind word and not with criticism about impracticality.

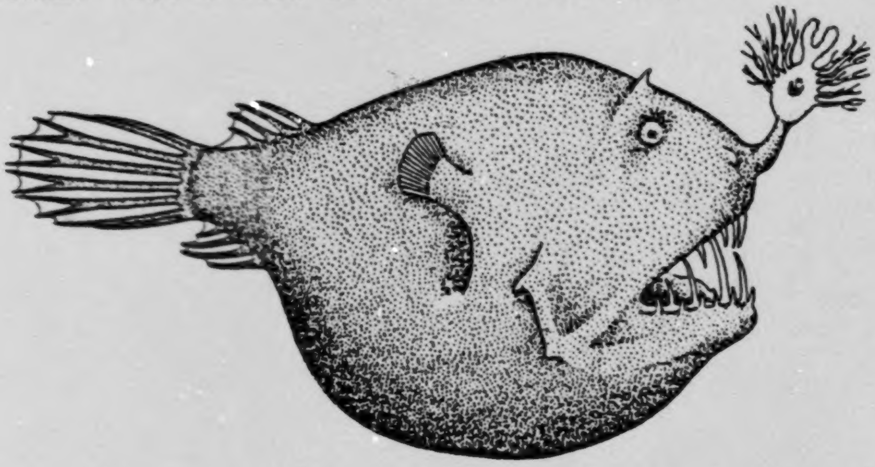
KEY WORDS

- angler
- appendage
- bottom dwelling
- compressed
- cubic
- depth
- hypothesized
- penetrates
- pressure
- square
- surface area

HOW LOW CAN YOU GO?

Hundreds of years ago,sailors on ocean going ships discovered that the ocean was thousands of feet deep. Scientists hypothesized that conditions in the deep ocean were so unfavorable that living creatures would not be found there. Much to their surprise, many different kinds of creatures were found. Why did scientists think no life could exist?

Ocean waters reach greater depths than any fresh water body. For example, the Mariana Trench in the Pacific Ocean is about 35,800 feet deep (about 6,000 feet deeper than Mt. Everest is tall). What effect do these great depths have on the life found on the bottom? Let's look at a bottom dwelling fish and see.



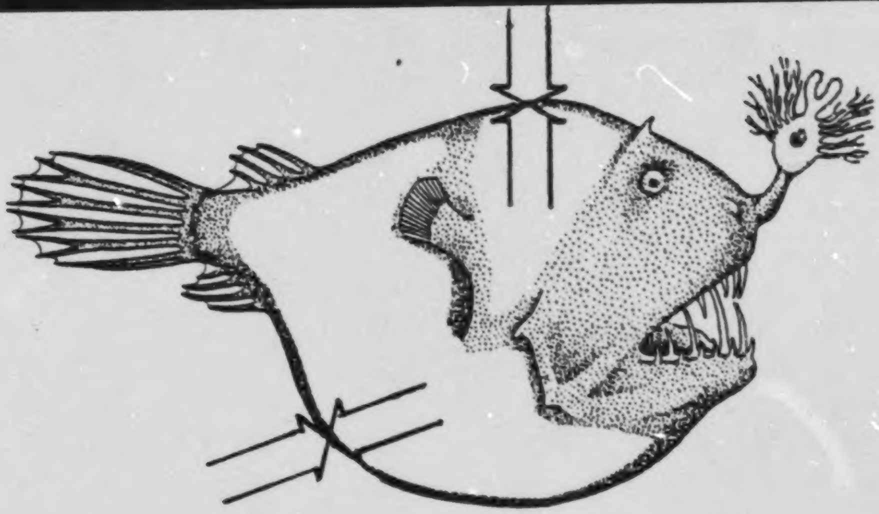
This fish is a deep-sea angler fish. It is found from 11,500 feet down in both the Atlantic and Pacific Oceans.

A cubic foot of fresh water weighs 62.4 pounds. Salt water weighs slightly more, about 64 pounds per cubic foot. A cubic foot is a block one foot high by one foot long by one foot wide. A fish that has a surface area of one square foot will have a force of about 64 pounds pressing down upon it at a depth of one foot. The same fish would have a force of 640 pounds per square foot at a depth of ten feet.

1. What would the force be on this same fish at a depth of 300 feet? Please show your work.

2. If the angler fish shown in the drawing has a surface area of one square foot, how much pressure will the fish be under at a depth of 20,000 feet? Please show your work.

At a depth of 3,000 feet the pressure is high enough to squeeze a block of wood to half its volume so that it will sink. Why isn't the deep-sea angler fish squeezed? The answer lies in the fact that there is pressure inside of the fish pushing outwards. The two pressures equal each other so the fish keeps its shape.



EQUAL PRESSURES

What happens as the fish moves up and down? The pressure changes on the outside of the fish. To keep its shape, it must be able to change the internal pressure, too.

3. What would the outside pressure on a deep-sea angler fish be at one foot in depth?

____

4. If the fish could not change its inside pressure, what would probably happen to the fish at the surface if the internal pressure remained the same?

____

____

The sunlight never penetrates to the depths where the angler fish lives. If it's always dark, how does the angler fish find its food? Look at the fish's "nose." The strange appendage glows in the dark. The angler fish remains still or slowly moves through the water. As it moves, it dangles the glowing "bait." The structure looks like wiggling worms.

5. What color do you think the rest of the deep-sea angler fish is? Why?

____

____

____

Curious fish move in for a closer look. The angler fish dangles the bait more invitingly. The fish moves closer. Suddenly, the angler fish opens its mouth wide. This causes water to rush into the mouth and the curious fish is sucked in with the water. Hello, dinner!

6. Which way do the angler fish teeth point?

____

7. What is an advantage of this tooth arrangement?

____

____

Occasionally, an angler fish attracts a fish too big to eat. If the angler fish cannot let go of the big fish, both fish die.

There is no light at the depths which angler fish live.

8. Does the angler fish have eyes?

____

The eyes are sensitive to light. This fact makes scientists wonder if angler fish do occasionally move up into the lighted zones of the ocean.

9. Describe an experiment to test the hypothesis that angler fish move up into lighted ocean zones.

The tremendous pressure and no light coupled with very low temperatures help explain why scientists thought no life would be found in the deep ocean.

Angler fish are just one of many strange and fascinating creatures found at great depths of the ocean. For further information read Abyss by C.P. Idyll, published by Thomas Y. Crowell Company, New York (1964).

TEACHER BACKGROUND - Ocean Currents

While this experiment can be done as a demonstration, it is recommended that the class be divided into small groups and that each group perform the investigations. This exercise deals with temperature and salinity currents. Emphasize that currents do exist and that they play an important and not all together understood role in the life of the oceans.

Duplicate the materials. One set per student.

It is important that you do this experiment before your class performs it. This will give you a chance to anticipate any difficulties. Try the 3 x 5 card on the top of the flask inversion trick for yourself. It really does work. Be sure your flasks, or jars have flat lips.

Groups of 3 or 4 students allow participation by all members. Watch to see that some don't adopt a passive spectator role.

Encourage careful observation and require written observations from the groups.

KEY - Interpretation - 1

1. Salt water is heavier. The colored salty water sank into the clear fresh water in experimental set up "a."
2. Since river water is fresh, it floats on top of the salt water until waves and currents cause the two to mix.
3. Freddy was fishing where the fresh water was standing in a layer above the salt water. Near the surface the water was the lighter river water, near the bottom the water was the more dense sea water.

KEY - Interpretation - 2

1. Warm water is lighter (lower density) than cool water. The warm, colored water remained in the upper flask in experimental set up "a."

2. Most heating occurs at the surface.

3. Most dilution of sea water occurs at the surface.

4. It is easier for a human to swim in salt water. The salt water makes the person more bouyant. Salt water is more dense and the same volume displaced by the person will weigh more, the person floats more easily.

5. It is easier for a human to swim in cool water. The person displaces the same volume but since the water is cooler and more dense it weighs more and the person floats more readily. A word of warning may be in order here. While a person will float more readily in cool water, the chance of excessive body heat loss increases. Cold water can lead to hypothermia. You may wish to discuss this so that your students use caution when experimenting on their own.

KEY WORDS

adjacent

climate

density

dilution

transport

OCEAN CURRENTS

People have observed ocean currents for many years. Currents are masses of water that flow in a definite direction. Ocean currents are important in many ways. They affect the climate of the lands nearby. The best fishing is often found where two currents come together. Currents can help transport boats. They also transport fish and shellfish that are too young to swim great distances.

There are several types of currents. The best known are wind-caused currents where the wind actually pushes the water along the surface. There are also deep currents beneath the surface. These currents are caused mainly by differences in the density of adjacent waters.

The experiment below will let you observe two of the lesser known factors that cause currents. You will observe differences in salinity and temperature densities between two masses of water.

MATERIALS

Two 1-pint milk bottles or two 250 milliliter Erienmeyer flasks with flat rims

Some 3 x 5 cards

Table salt

Food coloring

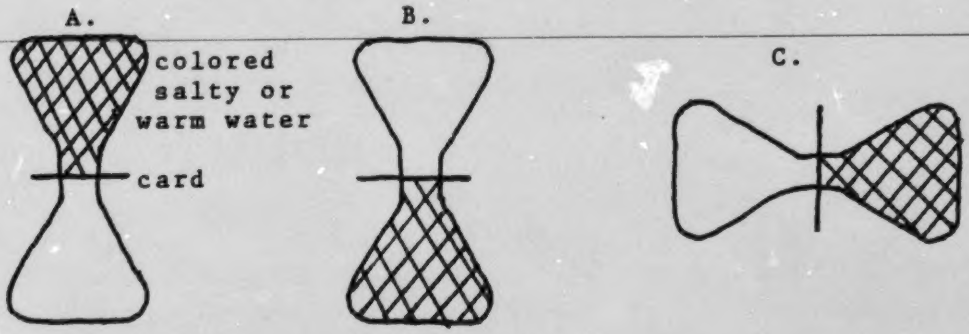
Paper towels or rags

Plastic dishpan or other container suitable to catch water

METHODS

Salinity Currents

1. Fill both bottles with water. Dissolve ½ teaspoon of salt in one bottle and add a drop of food coloring. Place a 3 x 5 card on top of the salt water bottle and carefully invert it; the upward pressure of air will hold the card in place (most of the time).
    a. Place the salt water bottle on top of the fresh water container and have someone remove the card. (Now is the time for the dish pan!) Observe results.
    b. Repeat No. 1 -- place fresh water jar on top of salt water jar, remove card and observe.
    c. Repeat No. 1 -- place both jars horizontally, remove card and observe.



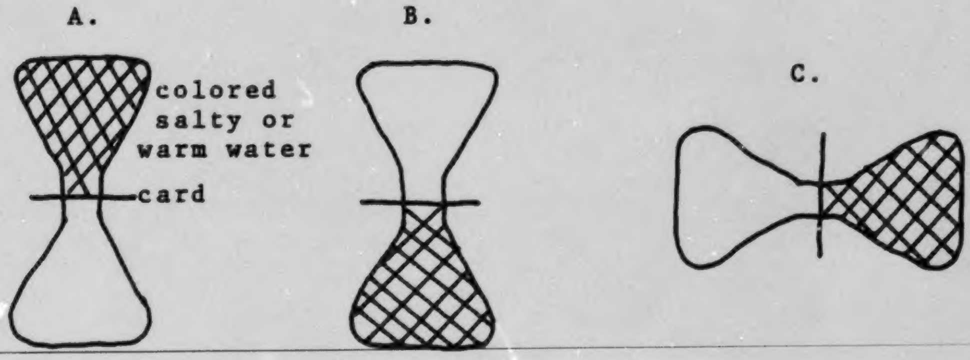
INTERPRETATION

1. Is salt water heavier or lighter (higher or lower density) than fresh water? Explain your answer in terms of the results you obtained from the experiment.
2. What happens to river water when it flows into the ocean?
3. Freddy Fisherman was fishing at a spot near the mouth of a river. Five feet down he caught a fresh water perch. His luck was so good he let out more line. At thirty feet he caught a salt water cod. Freddy is so excited about this strange occurrence he is going to call the

Sports Editor of the Post-Intelligencer. What would you tell Freddy to save him from embarassment?

Temperature Currents

2. Fill one bottle with warm water and the other with cool water. Add a drop of food coloring to the warm water. Do the three variations listed above in No. 1. (see diagram below).



INTERPRETATION

1. Is warm water heavier or lighter (higher or lower density) than cool water? Explain your answer in terms of the results you obtained on the above experiment.
2. Where does most heating of ocean water take place?
3. Where does most dilution of sea water occur?
4. Is it easier for a human to swim in salty or in fresh water? Explain.
5. Is it easier for a human to swim in cool water or warm water? Explain.

TEACHER BACKGROUND - Density Currents in a Model Ocean

This experiment provides an opportunity to make a small "ocean" and observe the currents caused by density differences due to temperature.

Data is collected for thirty minutes. This experiment is best done in groups of three or four rather than as a classroom demonstration.

Duplicate the materials. One set per student.

KEY - Interpretation

1. The answer depends upon the experimental results. If all went well, the paper should move out of the corner and toward the ice.
2. The paper shows a surface current.
3. The answer depends upon the experimental results. It will probably be the thermometer nearest the ice.
4. The answer again depends upon the experimental results. It will probably be the thermometer nearest the ice.
5. The answer again depends upon the experimental results. Most likely all will record a drop in temperature.
6. Depends upon results. Most likely, the thermometer farthest from the ice.
7. The ice cooled the water. The dense, cool water sunk and moved out across the bottom of the tray. The warm, light water flowed back toward the ice at the surface.
8. The dye should move across the bottom away from the ice.
9. The dye traces the movement of the water current.
10. It begins as a bottom current.
11. The dye curves at the other side and may move back across the surface. The current runs into the wall and moves accordingly.

KEY - Interpretation (cont.)

12. The counterparts of the cup of ice are the polar ice caps.

KEY WORDS

- bottom currents
- counterpart
- currents
- density
- model
- surface currents
- thermometer

DENSITY CURRENTS IN A MODEL OCEAN

We have seen that differences in the density of sea water can cause currents. In this experiment you will make a model ocean and study its currents.

MATERIALS

Large rectangular baking dish
Four aquarium thermometers
Paper cup with several small pin holes in the bottom
Masking tape
Crushed ice (enough to fill the paper cup)
Food coloring
Bits of paper

PROCEDURE:

Tape the paper cup in one corner of the baking dish so that there is about one-half inch between the bottom of the dish and the cup. Place the thermometers at regular intervals along the bottom of the baking dish. Be sure the bulbs are facing the same direction. Tape the thermometers in place. Add enough water so that the bottom of the paper cup is covered. Let the apparatus sit until there is no movement in the water.

Read each thermometer and record the temperature at time zero on the data chart. This is important because we are concerned with how much the temperature changes. Fill the cup with ice and add 5 - 10 ml of food coloring. Record the thermometer readings at five minute intervals for half an hour.

TIME (MINUTES)	THERMOMETER READING (°C)			
	1	2	3	4
0				
5				
10				
15				
20				
25				
30				

If you cannot see a bottom current after 25 minutes, gently heat the dish opposite the ice. Carefully place a large beaker of hot water inside the dish next to the edge.

After 30 minutes place a small piece of paper (about 1 cm square) on top of the water in the corner opposite the ice.

INTERPRETATION

1. In what direction does the paper move?

2. Does the paper movement show a deep current or a surface current?

3. Which thermometer changed the most during the time you read it?

4. Which thermometer had the fastest change?

5. Did all of the thermometers change temperature in the same direction? (Did they all get colder or hotter?)

6. Which was the last thermometer to show a temperature drop?

7. What could have happened to cause the changes you saw in the temperatures of the four thermometers?

8. What happened to the dye in the ice cup?

9. What does the dye movement tell you?

10. Is the dye movement a surface current or a bottom current?

11. What happens to the dye when it reaches the other side of the dish? Why?

12. A model imitates the real world. What is the counterpart of your cup of ice in the real world?

SEA WATER INVESTIGATIONS

TEACHER BACKGROUND - Now You See It, Now You Don't

This activity investigates salt water and bouyancy. It is a mystery to most people why some things float and others sink. This exercise will help explain some of the principles involved.

Duplicate the activity pages. One set per student.

Avoid the temptation to do this activity as a demonstration. Caution students to gently place the egg into the beaker or glass. Groups of two or three are ideal.

After all have finished the investigation and the questions, allow some time to go over the results and to provide the correct answers.

KEY - Questions and Interpretation

1. The water weighs the same as the individual. The answer, then, should be whatever the student's weight happens to be.
2. Since it sinks, a ten pound cement block must displace less than ten pounds of water.
3. The egg should sink.
4. The weight of the water displaced was less than the weight of the egg.
5. The egg will float in the salt water solution.
6. The weight of the water displaced by the egg equals the weight of the egg.
7. The weight of the water must have increased.
8. If you were going to dive in salt water you would need more weight since you are more bouyant. You displace "heavier" water and hence float more easily in salt water - just like the egg.

KEY WORDS

- displace
- dissolve
- float
- heaping
- scuba (Self-Contained Underwater Breathing Apparatus)
- sink

NOW YOU SEE IT, NOW YOU DON'T

Why do some things float whole others sink? When we place an ice cube in a glass of water, the ice cube displaces, or pushes out of the way, some water. We can see that some of the water is displaced when we notice that the level of the water in the glass has risen. If we weighed the amount of water displaced, we would find that the weight of water displaced is the same as the weight of the ice cube.

AN OBJECT FLOATS WHEN IT DISPLACES AN AMOUNT OF WATER EQUAL TO ITS WEIGHT.

1. When you float in the water, how much does the water weigh that you are displacing? ______________________________

If an object displaces an amount of water equal to LESS than its weight, it will sink.

2. A ten pound cement block must displace less than how many pounds of water? ______________________________

Let's use this information to look at an interesting situation.

MATERIALS

Drinking glass or beaker (400 ml)
Fresh egg
Table salt (sodium chloride)
Tap water
Spoon or stirring rod

METHOD

1. Fill the drinking glass with tap water.
2. Carefully lower the egg into the water.

INTREPRETATION

3. What happened to the egg when you lowered it into the water?

____

4. Did the weight of the water displaced by the egg equal the weight of the egg or was it less than the weight of the egg?

____

METHOD

3. Remove the egg from the glass.
4. Add two heaping (very full) tablespoons of salt to the water.
5. Stir the water until the salt is dissolved.
6. Carefully lower the egg into the water.

INTERPRETATION

5. What happened to the egg when you lowered it into the salt water solution? ____

6. Did the weight of the water displaced by the egg equal the weight of the egg or was it less than the weight of the egg?

____

7. Since we can assume that the weight of the egg did not change during the course of the experiment, what must have happened to the weight of the water to cause the results you observed?

____

____

8. SCUBA divers wear weight belts to help them to stay underwater. If you were going to dive in salt water, would you need more or less weight than you would need in fresh water? Explain your answer. ____________________________________

____

TEACHER BACKGROUND - Salty Dog

"Salty Dog" is a quantitative look at sea water. The students will determine just how much salt is in a given sample of sea water. This investigation provides an opportunity for careful measurement.

A balance and weights or a scale capable of weighing 50 grams accurately is required. If you do not have one in your class, plan to obtain one from another teacher even if you have to go to the high school and borrow one! The same goes for the graduated cylinders. Several of each will make the lab go faster. If you only have one or two, you can run this activity simultaneously with "Now You See It, Now You Don't." In this way, you can avoid long lines for the equipment. It is also possible to do this investigation as a demonstration. Demonstration is less preferable than student inquiry, but is better than skipping the activity. If you do choose the demonstration route, demonstrate without providing all of the answers. Provide the data and let the students work out the solutions to the questions you pose.

If you are not close to a source of sea water, you can make your own for this experiment. Dissolve 32 grams of table salt (sodium chloride) in 1 liter (1000 ml) of tap water. If you find that the solution is cloudy, you can let it stand and the cloudy precipitate will settle. The precipitate is usually aluminum silicate, a material that keeps the salt from caking. (While making us shiny inside?)

NOTE THE CAUTION. Do not let the beakers boil dry on the hot plate. They will crack even though they are heat-resistant pyrex glass. Have students reduce temperature at this point. It is also helpful to slightly tilt the beaker to reduce the spattering of salt.

Duplicate the activity sheets. One set per student.

KEY - Questions

Answers in the experimental procedure section will depend upon results.

1. Answer depends upon results. The sample should fall within the range.

2. Results will differ. Differences may come from errors in weighing, errors in measuring, errors in recording, etc.

3. Salt enters the sea from fresh water rivers. The salt is in very low concentration in the fresh water. As water evaporates from the surface of the ocean, the salts are left behind and the concentration of salts or salinity of the ocean increases.

KEY WORDS

balance

beaker

evaporate

graduated cylinder

grams

residue

salinity

salty

thermometer

weigh

SALTY DOG

Most of us know that when we compare sea water with fresh water it tastes salty. But just how salty is sea water and what are some ways in which salt makes sea water different from fresh water?

MATERIALS

Beaker (150 or 250 ml)	Balance and weights
Thermometer	Graduated cylinder
Sea Water	Hot plate
Beaker tongs	Stopwatch or timer
Tray - heat resistant	

PURPOSE:

Weigh and measure 50 ml of sea water using the above mentioned equipment. Then evaporate the water and calculate the per cent of salt as well as the salinity of the sample.

PROCEDURE:

1. Weigh empty beaker using balance ______________________grams.
2. Measure 50 ml sea water using a graduated cylinder, then pour into the beaker.
3. Weigh beaker with the sea water in it __________________grams.
4. To determine weight of water subtract #1 from #3.

#3 _________grams

Subtract #1 _________grams

Weight of Water = _________grams

5. Place beaker on hot plate and evaporate all the water.

NOTE: Record the time and temperature at which the sea water begins to boil. CAUTION: Don't let the beaker boil completely dry as beaker will crack.

As the water is being evaporated, record the temperature every 2 minutes.

Remove beaker from hot plate and place on tray.

Starting Temp. ____________ 10 min. ____________ 20 min. ____________

2 min. ____________ 12 min. ____________ 22 min. ____________

4 min. ____________ 14 min. ____________ 24 min. ____________

6 min. ____________ 16 min. ____________

8 min. ____________ 18 min. ____________

Boiling Temperature ____________________

6. Weigh beaker with dry salt residue left in it ____________ grams.

7. To find the weight of salt, subtract #1 from #6.

#6 ____________ grams

Subtract #1 ____________ grams

Weight of Salt #7 = ____________ grams

8. The percent of salt is found by multiplying the weight of residue by 100 and then dividing by the weight of sea water used.

Weight of #7 __________ grams

______________ = ________ grams X 100 = ________

Weight of #4 __________ grams (per cent)

9. The salinity of ocean water is commonly expressed by so many parts of salt material per 1000 parts of water. We use the symbol 0/00 to express parts per thousand. To determine parts per thousand take the per cent of salt and multiply by 10.

Per cent of salt __________ X 10 = __________ 0.00

QUESTIONS:

1. The salinity of sea water usually ranges from 25 parts per thousand to 34 parts per thousand. Does your sample fall in that range?

____

2. Compare the salinity of sea water that you obtained with the results of other groups. Do they differ? If so, what might have caused the differences?

____

____

____

____

3. How does salt get into the sea?

____

____

____

____

TEACHER BACKGROUND - Cold As Ice?

In this activity, we investigate another property of salt water. If limited freezer space is available, this activity may be performed as a demonstration. Freezer space can usually be borrowed from the kitchen crew in exchange for a smile and a kind word.

Duplicate the activity pages. One set per student even if this is done as a demonstration.

KEY - Interpretation

1. Depends upon the experimental results. Usually: solution 4 freezes first. The highest salt concentration, solution 1, does not completely freeze.
2. Usually solution 1
3. Usually solution 4
4. Higher the salinity the longer it takes to freeze. Actually, we see that the higher the salinity the lower the freezing point.
5. Icebergs are fresh water. The solutions 2 and 3 which show partial freezing show the fresh water portion leaving as ice.
6. Yes, the water at the surface will freeze.
7. The process will continue until the water is ice from top to bottom.
8. No, they would run into the ice mass.
9. The lakes and ponds would freeze solid from bottom to top. The ice would be as thick as the lake is deep. The fish would be caught in the ice and freeze to death.

KEY WORDS

- compound
- density
- generalization
- nuclear submarines
- observe
- properties
- record
- solution

COLD AS ICE ?

We know that water freezes at $0^{o}C$ ($32^{o}F$) or does it? Ice and water are the same chemical compound. Yet, we know they look and behave differently. This activity will give you a chance to learn something about the properties of ice and water.

MATERIALS:

Table salt (sodium chloride)

Tap water

Tablespoon measure

Plastic ice cube tray with divided, water-tight sections

4 small(400 ml) jars or beakers

Waterproof labels or grease pencil

METHOD:

1. In separate container, mix the four solutions as follows:

   Solution No. 1: mix 9 level tablespoons salt with 1 cup tap water.

   Solution No. 2: mix 6 level tablespoons salt with 1 cup tap water.

   Solution No. 3: mix 3 level tablespoons salt with 1 cup tap water

   Solution No. 4: Pure tap water.

2. Label one-fourth of the sections of the ice tray (how many is that? Hint: multiply the number of sections by .25) with number 1, one-fourth with number two, and so on.

3. Pour the four solutions into different sections of the ice cube tray. (Make sure the water in each section does not mix with that in other sections.) Then place the tray in a freezer.

4. Observe and record conditions after 1 hour, 24 hours and 48 hours.

SOLUTION	1 HOUR	24 HOURS	48 HOURS
No. 1			
No. 2			
No. 3			
No. 4			

INTERPRETATION:

1. List the results you obtained for each of the four solutions:

   Solution No. 1

   Solution No. 2

   Solution No. 3

   Solution No. 4

2. Did any solution fail to freeze? If yes, which one?______________

3. Which solution was first to freeze? ______________________________

4. State a generalization (a statement that covers many situations) that describes what happens to the speed at which water freezes as the salinity changes.

5. From your experimental results, are icebergs salt or fresh water?

   (Hint: you might taste the ice from the fresh water and compare it with the ice from the salt water sample).

   Explain how you reached your conclusion.

Most materials get more dense ("heavier") as they change from a liquid to a solid. Water is unusual in that it is most dense at about 4^{o}C. If it was most dense as a solid, ice would sink.

Let's imagine that you're captain of the Polar Star, an ice breaker, on duty in the Arctic Ocean. The temperature drops to below zero and the water begins to freeze on the surface. But instead of floating, the ice sinks!

6. Will the water now at the surface freeze if the temperature remains the same?

7. How long will this process continue if the ice continues to sink?

8. If ice sank, would nuclear submarines be able to sail under the frozen north pole? Explain.

9. What would happen to lakes and ponds that freeze in the winter if ice sank? How thick would the ice be? What would happen to the fish in the lake?

PHYSICAL FEATURES OF THE MARINE ENVIRONMENT

TEACHER BACKGROUND - Physical Features of the Marine Environment

The next two activities deal with the geology of the ocean floor.

Water covers 75% of the planet Earth, thus there is more land under the water of the planet than there is above the water for man to inhabit. Of this vast watery covering, about 71% of the 75% consists of salt water, mostly in inter-connected water bodies. Therefore, since so much land is below the water, much like an iceberg which has its greatest portion under water, we must topographically name these areas.

The first distinction we must make is that of naming the sea and ocean floor regions, as contrasted to the water which lies over these ocean floor regions. The ocean floor regions are called benthic and the water regions are called pelagic. The benthic region may be divided as follows:

1. Supralittoral
2. Littoral
3. Sublittoral
4. Archibenthic
5. Abbysalbenthic

Definitions of the above benthic divisions are included in the teacher outline.

The water region is divided into two zones; the neritic zone includes the water over the continental shelf, and the oceanic zone includes the water which lies seaward of the continental shelf. Characteristic differences occur in each of the bodies of water. For example the netric zone contains the following:

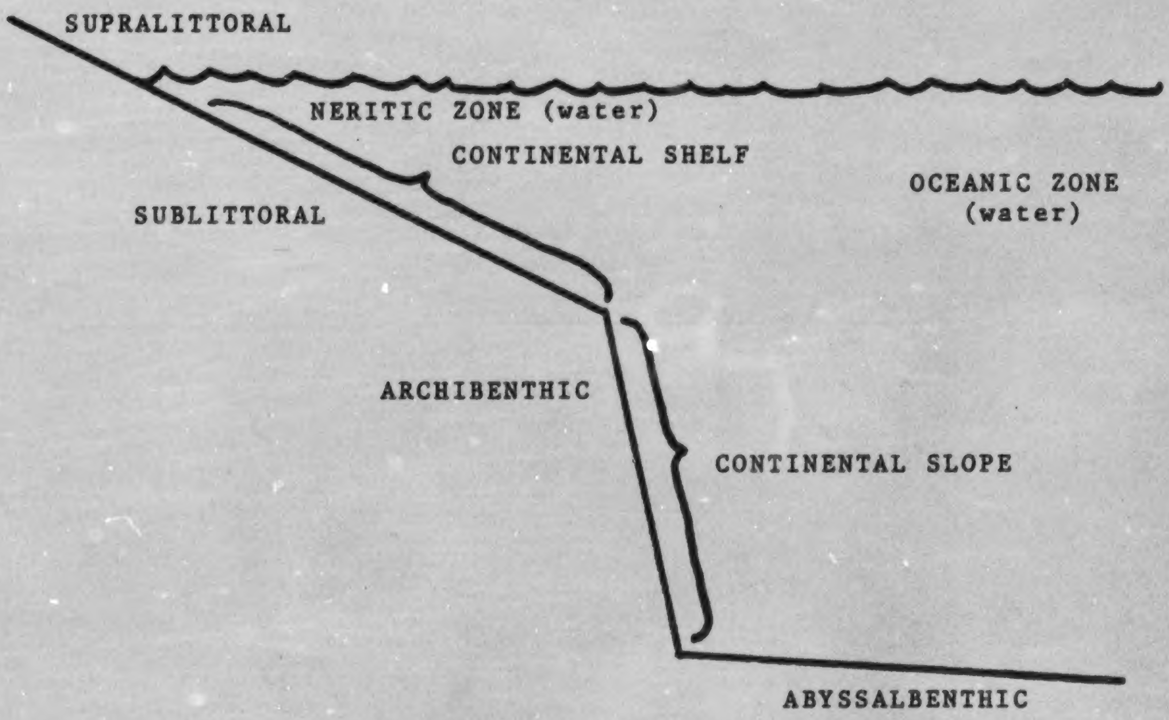
1. Low salinity
2. High nutrients
3. Great temperature change
4. Great evaporation

The oceanic zone contains the following:

1. Clear water
2. High salinity
3. Stable temperature
4. Desert of the ocean

Because of these characteristic differences the neritic zone is able to support the most abundant life. It is this area which supports the attached plants as well as the majority of fish.

OCEANOGRAPHIC TOPOGRAPHY


SUPRALITTORAL
NERITIC ZONE (water)
CONTINENTAL SHELF
OCEANIC ZONE (water)
SUBLITTORAL
ARCHIBENTHIC
CONTINENTAL SLOPE
ABYSSALBENTHIC

The oceans can be divided into specific divisions relative to fairly stable boundaries based on light penetration and depth. These vertical divisions, based on light penetration, have been designated as the photic zones. The portion of the ocean in which sunlight penetrates to the greatest degree and in which plant growth occurs is called the euphotic zone. This zone extends from the surface to a depth of about 85 to 90 feet in Puget Sound and extends deeper in areas where the water is clearer. The area in which sunlight is not sufficient for plant growth is called the aphotic zone.

OUTLINE: PHYSICAL FEATURES OF THE MARINE ENVIRONMENT

I. Benthic region -- sea or ocean floor region
    A. The sea floor from high tide to continental shelf
        1. Supralittoral -- (upper) beach above high tide (splash zone)
        2. Littoral -- (middle) beach between high and low tides
        3. Sublittoral -- (lower) from the point of low tide to the edge of the continental shelf
    B. The sea or ocean floor beyond the edge of the continental shelf
        1. Archibenthic -- the continental slope area
        2. Abbysalbenthic -- the ocean floor beyond the continental slope

II. Pelagic region -- the water over the sea or ocean floor
    A. Neritic zone -- water which lies above the continental shelf; having the following characteristics:
        1. Low salinity
        2. High nutrients
        3. Great temperature change
        4. Great evaporation

B. Oceanic zone -- water which lies seaward of the continental shelf; having the following characteristics:

   1. Clear water
   2. High salinity
   3. Stable temperature
   4. Desert of the ocean

C. Photic zones -- sunlight penetration into water

   1. Euphotic -- sunlight penetration sufficient for plant growth
   2. Aphotic -- sunlight penetration not sufficient for plant growth

TEACHER BACKGROUND - Measuring the Ocean Depths

This activity provides for a hands on examination of ocean floor features. "Measuring the Ocean Depths" also provides practice in graphing and point plotting.

Shoe boxes can be provided by the students.

Duplicate materials for activity. One set per student.

Have the students keep the models simple. There will be a tendancy for them to create complex systems of mountains and valleys.

Explain the marking of the coordinates and the technique for punching the holes. Choose a technique that will not result in injury to your students.

Show a completed box and leave it on display as a guide.

Explain the mapping procedure and show a finished map. You can obtain one from the next activity, "Bathymetric Mapping."

This activity may be performed individually or in small groups depending upon your preference.

A good way to foster enthusiasm is to display the student's contour maps on a bulletin board in the classroom.

KEY - Interpretation

1. Answer depends upon results. A mountain will give a series of decreasing depth readings as you go up the sides and increasing depth readings as you go from the summit down.

2. Answer depends upon results. A canyon would have increasing depths to the bottom, then decreasing depths up to the plain.

3. Depends upon results.

4. You could miss a feature by incomplete sampling of depths.

5. Small features, or features without great relief would be the easiest features to miss.

6. Depends upon the results obtained. Hopefully the two are similar.

7. Small numbers (shallow depths) show the presence of a canyon.

8. Close contour lines indicate a steep slope.

9. No, they probably missed many features. They could not completely sound all of the depths in all the areas they charted.

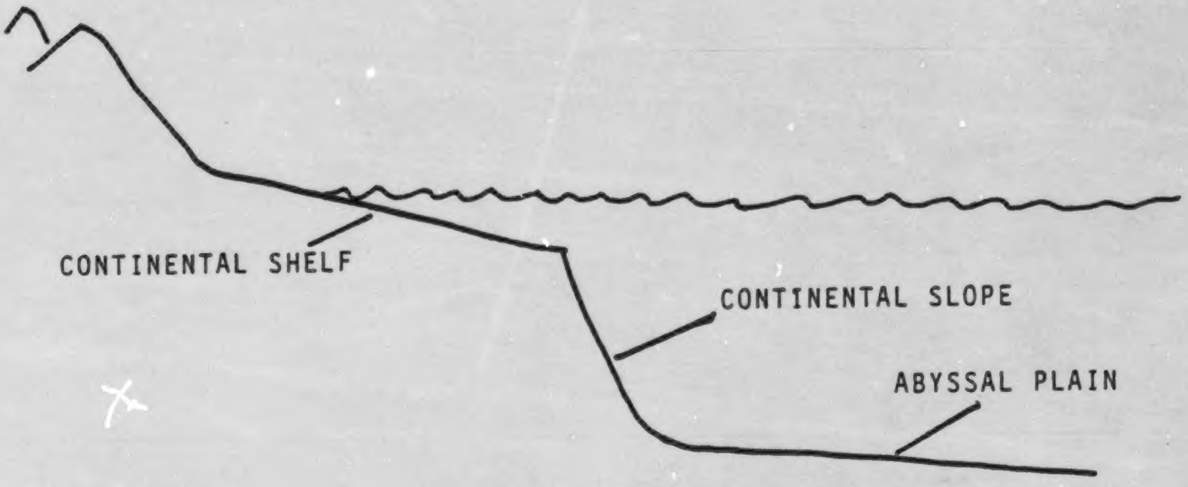
KEY WORDS

- abyssal plain
- basin
- continental shelf
- continental slope
- contour
- depression
- elevation
- Island
- oceanographers
- ridge
- taking a sounding
- trench

MEASURING THE OCEAN DEPTHS

Let's suppose that all of the water in the oceans disappeared. What would the sea floor look like? The elevations (high areas) and the depressions (low areas) would look like those found on land. We'd see mountains and valleys. Mountains higher than Mt. Everest. Valleys deeper than Death Valley.

The three main parts of the ocean floor are the continental shelf, the continental slope and the abyssal (a-bis-el) plain or basin.



THE OCEAN FLOOR

The continental shelf is the gently sloping edge of the continent. At ocean depths of about 500 feet, the ocean floor drops sharply. The steeply sloping area is called the continental slope. The abyssal plain or ocean basin begins where the continental slope ends.

The abyssal plain is not flat. There are mountains, ranges of mountains, trenches and ridges which break up the plain.

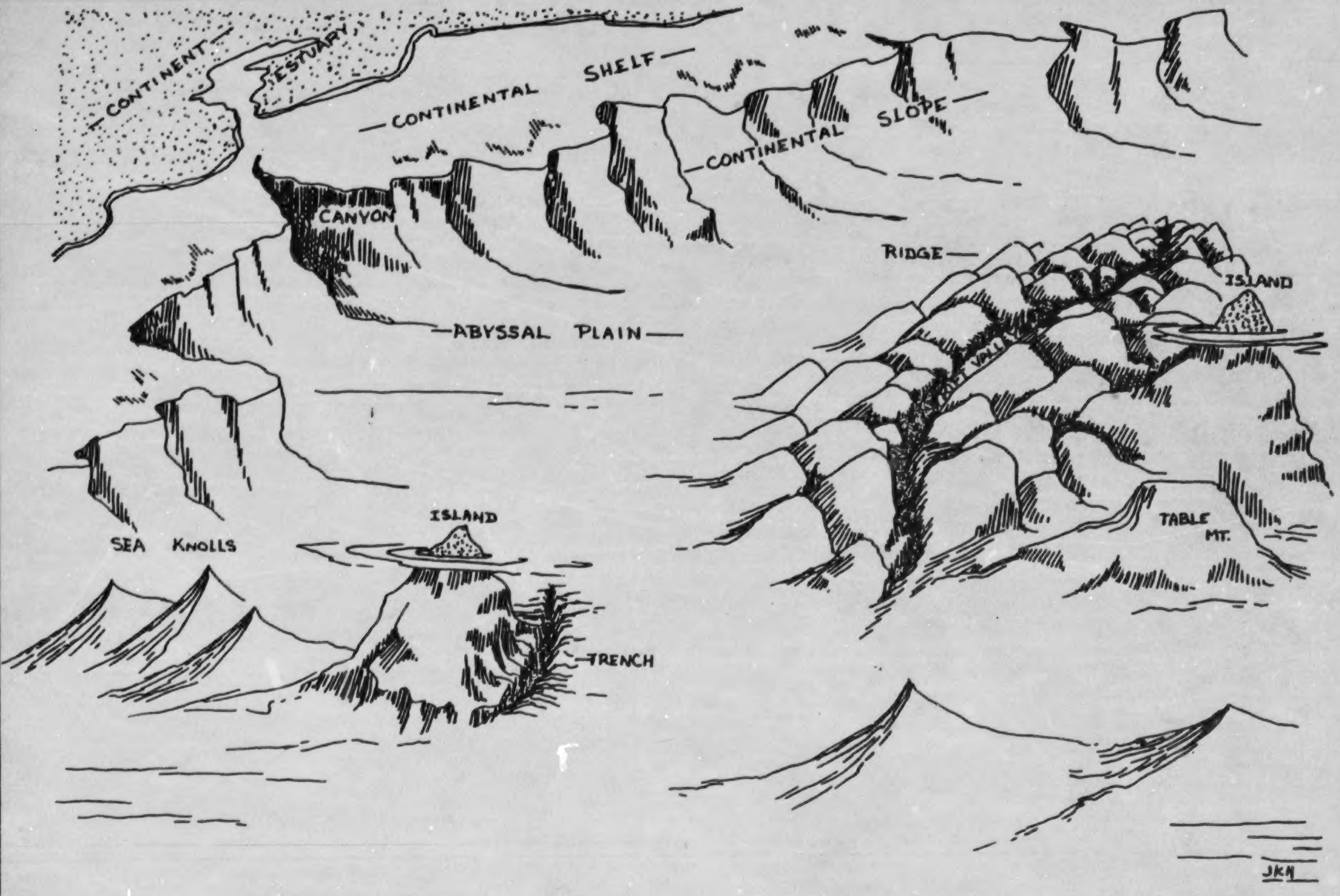
Where mountains rise above the surface of the ocean we have islands.

Oceanographers have discovered the shape of the ocean floor by measuring the depths of the water. Measuring the depth is called taking a sounding. Originally a weight on a marked wire or rope was lowered over the side and the depth read from the rope. Today sound waves are used to obtain a "picture" of the contours of the ocean floor.

The next page shows some of the landmarks you might see on the ocean floor.

MATERIALS

Shoe box with lid
500 milliliters (ml) flour*
500 ml salt
250 ml water
Plastic soda straw
Graph paper
Felt-tipped pen
Ruler marked in centimeters (cm)
Pencil, compass or scissors
* 250 ml = 1 cup


CONTINENT
ESTUARY
CONTINENTAL SHELF
CONTINENTAL SLOPE
CANYON
ABYSSAL PLAIN
RIDGE
ISLAND
VALL
TABLE MT.
SEA KNOLLS
ISLAND
TRENCH
JKM

OCEAN FLOOR

METHOD

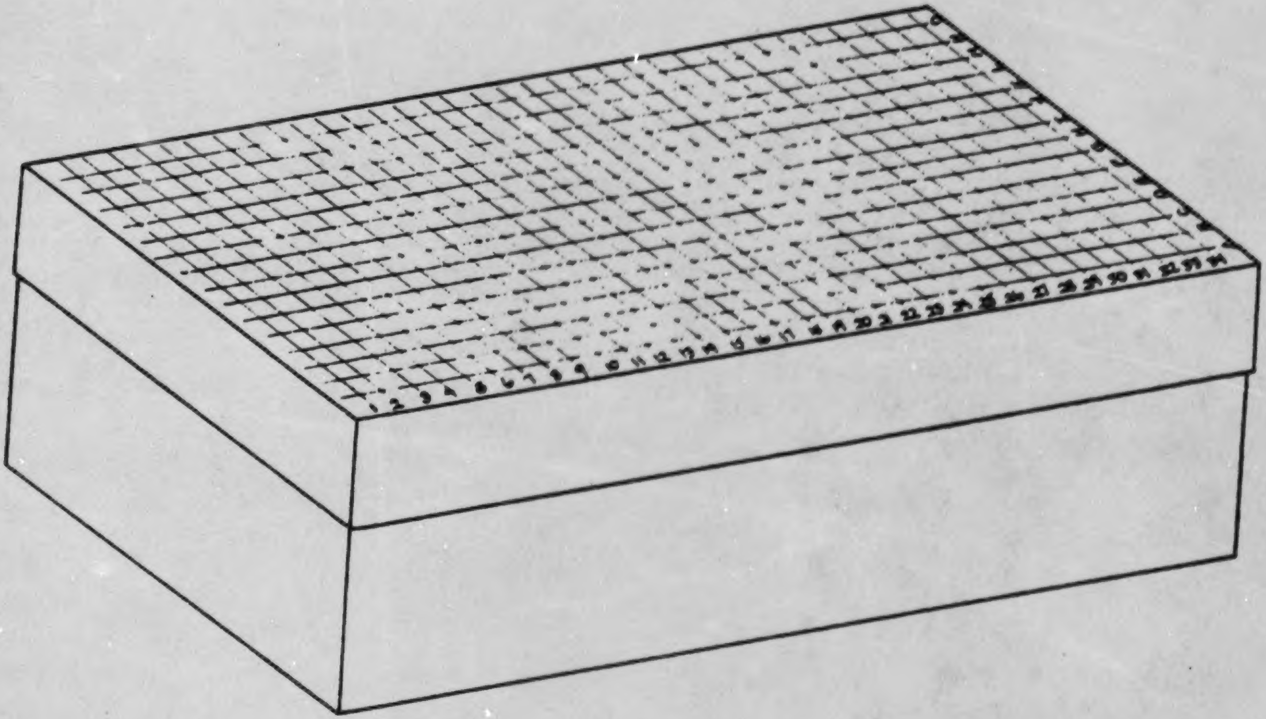
Day 1

1. Mix the 500 ml flour and 500 ml of salt.
2. Add the 250 ml of water to the dry mix of flour and salt. Mix well. The mixture should be like a stiff putty.
3. Use the plaster to build a model of the ocean floor in the shoe box. Use the ocean floor drawings as a guide. Keep the models simple (for example, an ocean floor with a mountain or one that has a trench or continental shelf).
4. Put names on boxes
5. Allow the plaster to dry

Day 2

1. Exchange boxes.
2. Mark both short edges of the box at 1 cm intervals. On one side label each mark with a letter beginning with "a" (a, b, c, d, etc.)
3. Mark both long edges of the box at 1 cm intervals and on one side, label with numbers beginning with "1" (1, 2, 3, etc.).
4. Connect the marks on the opposite short edges with lines.
5. Connect the marks on the long edges with lines. The box lid should now have a grid drawn on the top like the box in the next figure. The grid will be used to locate sample sites on the box.

Each box should look something like this



6. Copy the grid pattern on a piece of graph paper. (Hint: if you have trouble, you can simply lay the paper over the top of the box and trace the marks onto the paper.)
7. Where the lines intersect (cross), punch small holes (the size of the diameter of the soda straw) with a pencil, compass or scissors. These holes will be the sample sites. You can locate the sample sites by use of letters and numbers on the edges of the top. For example, sample site 1 might be at a-1, the second at c-2 etc.
8. Use the ruler and felt tip pen to mark off the soda straw into 1 cm intervals.

9. Take depth readings (soundings) in the box by inserting the straw straight down until it touches the ocean floor. Record the depth reading at the sample site location on your graph paper.

10. Take as many depth readings as you think are necessary to determine the nature of the ocean floor.

11. After all depth readings have been recorded, draw a pencil line connecting all the depth readings that are the same. For example connect all readings that are 5 cm, then connect all those that are 8 cm, etc. The lines should not have sharp angles and they should never cross. These lines are called contour lines and will show the features of the ocean floor.

INTERPRETATION:

Study your map. You have just made a bathymetric map, a map which shows the features of the ocean floor. Use your map and the other maps of the ocean floor to answer the following questions.

1. Does your piece of the ocean floor contain a mountain? How can you tell? ______________________________

   ____

2. Does your piece of the ocean floor contain a canyon? How can you tell? ______________________________

   ____

3. What other features are present in your piece of the ocean floor? ______________________________

   ______________________ ______________________

4. Could you have missed a feature? Explain. ____________________

5. What kind of features would be the easiest to miss? ___________

REMOVE THE TAPE AND OPEN YOUR BOX

6. How does your map compare with what is really present? _______

7. What kind of numbers (large or small) show the presence of a mountain? Of a canyon? ________________________

8. What information can you learn when you see that the contour lines on a map are close together? ________________

9. The techniques you used are essentially the same as those used by early navigators to chart the depths of the ocean. Do you think they obtained a completely accurate picture of the ocean floor using these methods? ____________________

TEACHER BACKGROUND - Bathymetric Mapping

This activity is a logical extension of "Measuring the Ocean Depths."

Duplicate the activity. Each student should have a set of materials. This activity is best performed on a individual basis. Some pooling of results might be helpful.

Map 3 can be used to evaluate the success of the activity. If done properly, a dolphin fish will appear.

KEY - Interpretation

1. There are several possibilities.

2. The geologic formations were probably found by sounding the depths and recording the figures. From the data, charts were prepared.

3. You would want to study a chart to keep from running aground. and to keep from getting your fishing gear stuck on the bottom.

4. Differences may be due to practice or, perhaps, the professionals had additional information that was not provided to the students.

KEY WORDS

abyssal plain

adjacent

bathymetric

continental shelf

continental slope

contour

geologic

interval

seamount

soundings

BATHYMETRIC MAPPING

The activity "Measuring the Ocean Depths" lets you see how the information to make bathymetric maps is gathered. In this activity the National Oceanic and Atmospheric Administration has done all the work for you. All of the soundings are made, all you have to do is draw the contour lines to connect places of similar depth.

MATERIALS:

Maps

Pencils

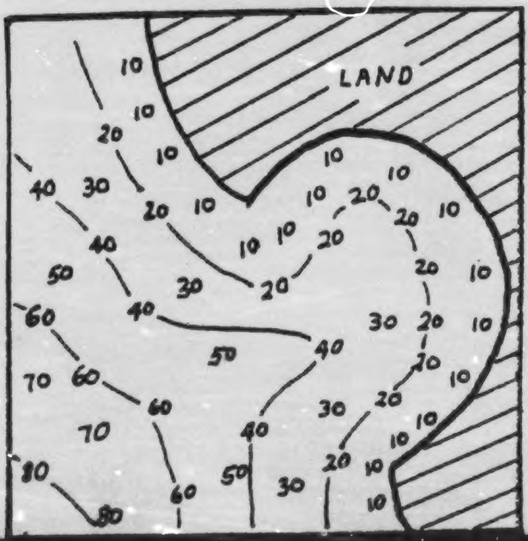
METHOD:

1. Using map 1, Cape Blanco to Cape Sebastian, connect areas of equal depth with pencil lines. See the diagram below. Connect the depths in this way:
    - a) From zero depth to 100 meters the interval between contour lines next to each other is 20 meters. (For example draw lines at 20 m, 40 m, 60 m, etc.)
    - b) From 100 meters depth to 500 meters, the interval between adjacent lines is 100 meters.
    - c) Connect the 1000 foot contour.

REMEMBER: EQUAL DEPTH CONTOUR LINES NEVER CROSS ONE ANOTHER.

EXAMPLE

COMPLETED
BATHYMETRIC
CHART


LAND
10
10
20
10
40
30
20
10
10
10
20
20
10
40
10
10
20
50
30
20
20
10
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30
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10
50
40
20
70
60
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70
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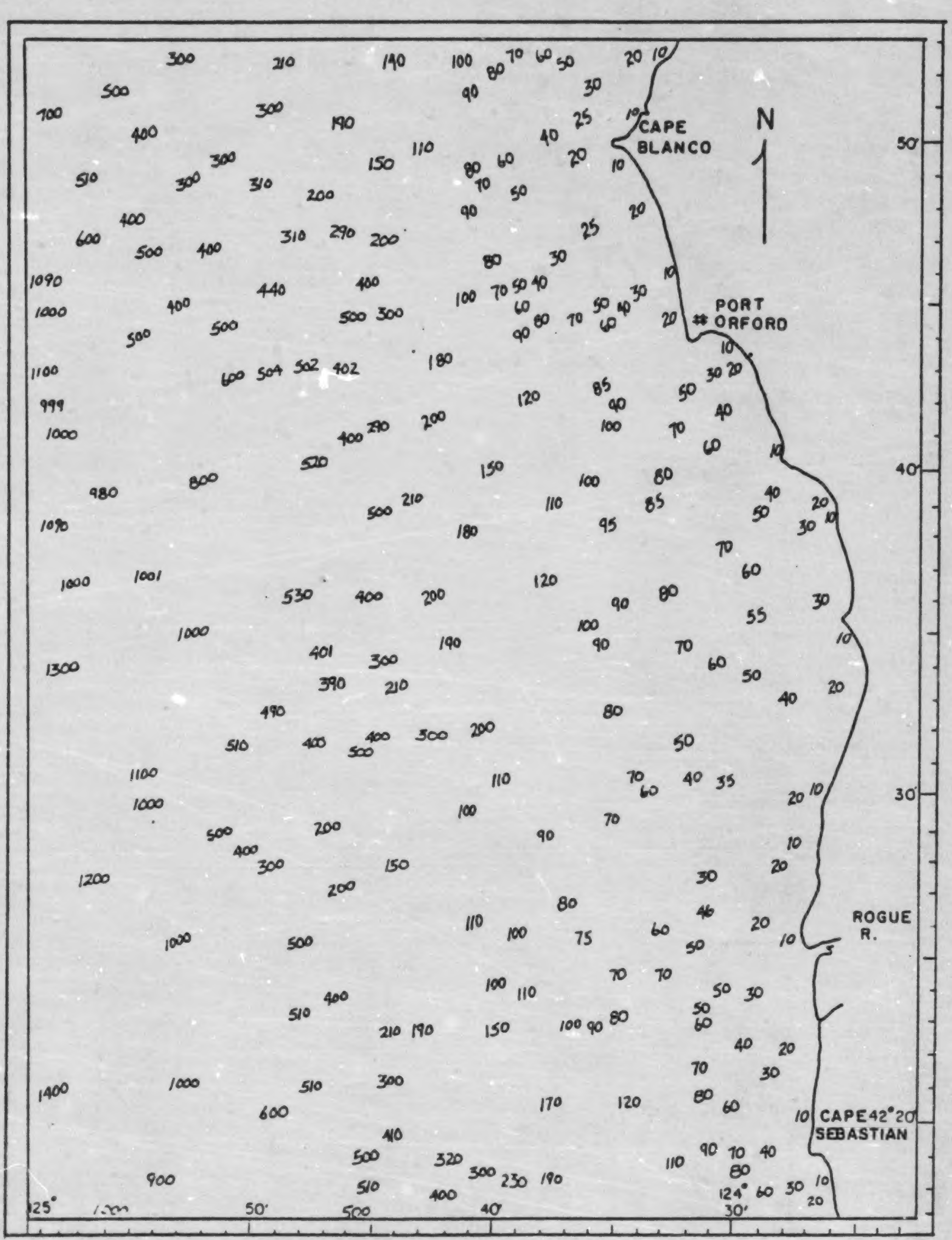
10
40
10
80
50
30
20
10
60
80
10

MAP 1

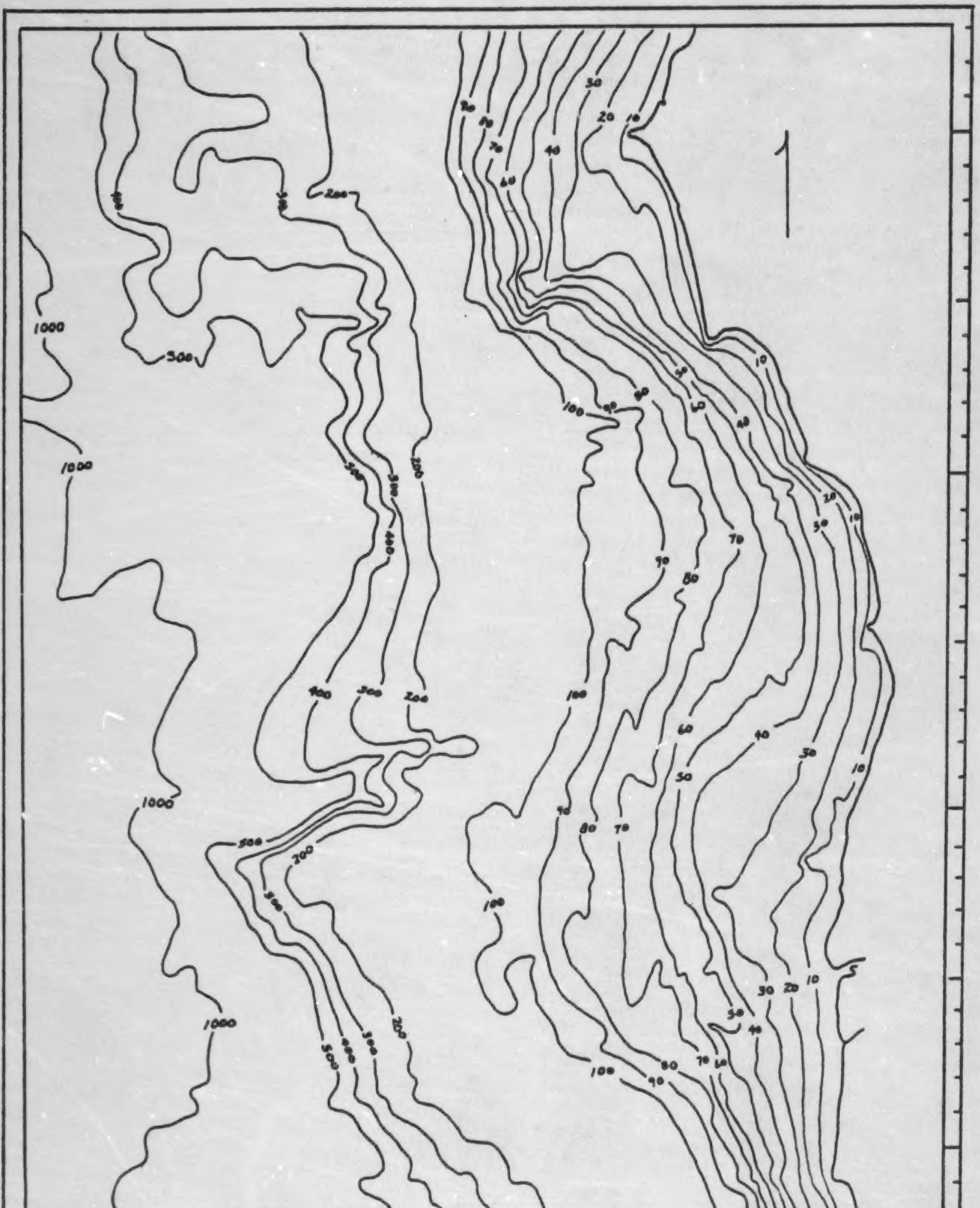

N
CAPE BLANCO
PORT ORFORD
ROGUE R.
CAPE SEBASTIAN
42°20'
50'
40'
30'
125°
50'
40'
30'
124°

2. Compare your map with the contour map 2 of the area drawn by ocean scientists.
3. Answer the questions in the Interpretation section.
4. Plot the equal depth contours on the third map. Connect areas of similar depths with a pencil line. Remember not to cross any lines.

INTERPRETATION:

1. Study your map and label the following things:
   - a) the continental shelf
   - b) the continental slope
   - c) a submarine (underwater) canyon
   - d) a seamount (underwater mountain)
   - e) the abyssal plain
2. How might the geologic formations (mountains, canyons, etc.) shown on your map have been found?
3. Suppose you are the skipper of the Mary Kay, a salmon troller. You hear of good fishing near Cape Blanco and head for the area. What are two reasons you would want to study a bathymetric chart before you begin fishing?
4. If the map you drew was different from the map drawn by professionals, how can you account for the differences?

MAP 2


30
20
10
90
80
70
40
60
100
200
1000
500
1000
100
90
80
40
60
80
10
40
20
30
10
70
90
80
500
300
200
400
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1000
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200
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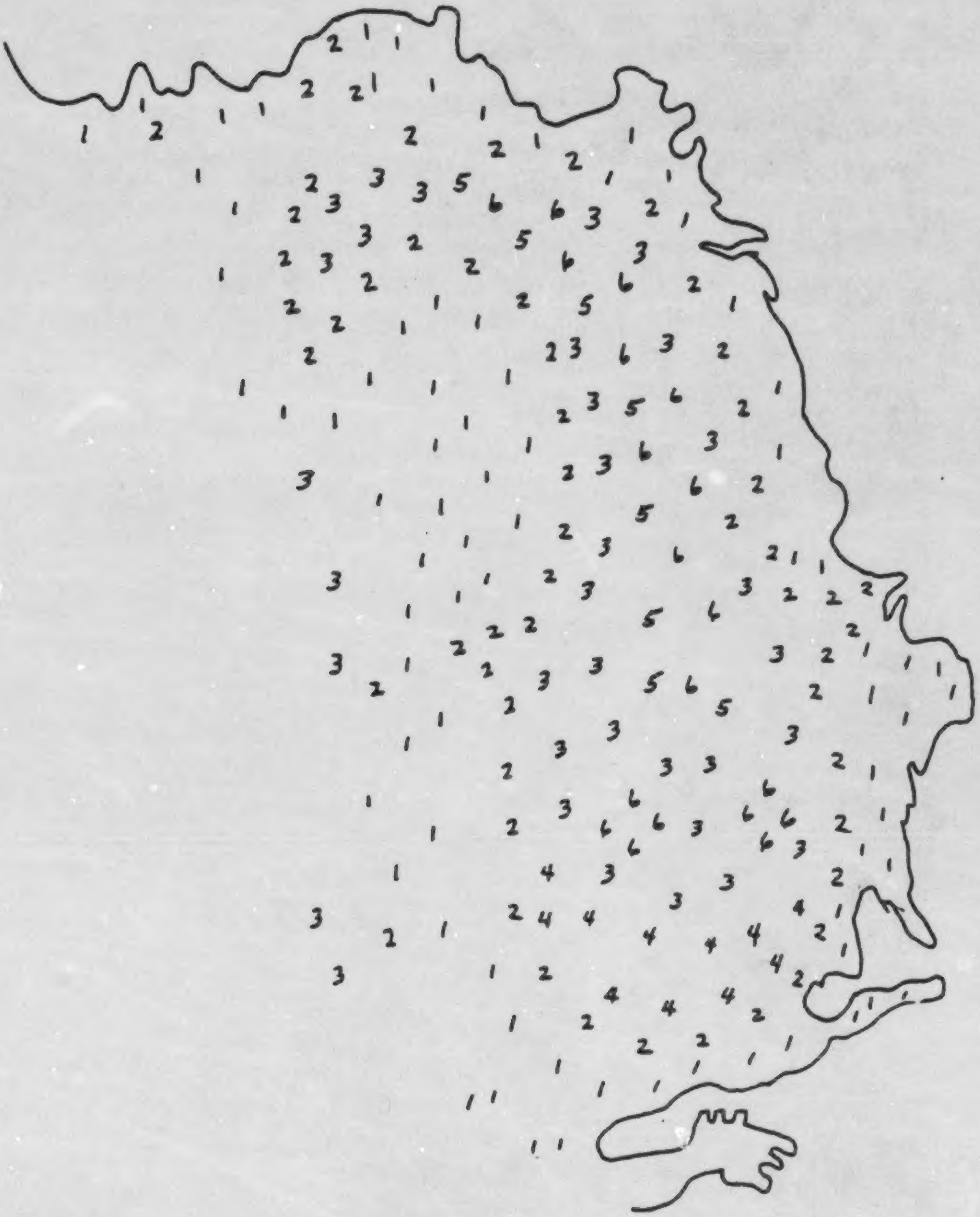
400
500
200
100
90
80
70
60

MAP 3



OCEANOGRAPHIC INSTRUMENTS

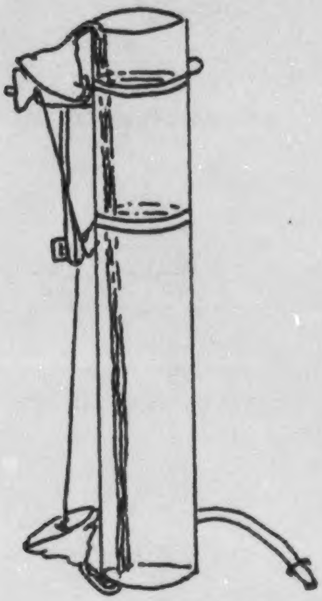
TEACHER BACKGROUND - Hydrometer Salinity

This investigation requires some specialized equipment that you may have to borrow. Hydrometers are available in aquarium shops for a reasonable sum. They can also usually be borrowed from high school chemistry or biology teachers. This is a good chance for some vertical integration in your curriculum! If you can only obtain one or two hydrometers, fear not. You can have the students work on the activity "What's That Sound?" simultaneously. Small groups can use the hydrometer. If you do not feel comfortable with this approach, you can do the activity as a demonstration. Provide the data and stimulate discussion through questions. Avoid answering all of the questions at this time.

Ideally you will obtain two water samples using a device like that shown on the next page. One sample should come from 1 meter below the surface and the second should come from the bottom. If you cannot obtain the samples in this manner you can still use the activity by making your own salt water samples. For the top sample, dissolve 29 grams of table salt (sodium chloride) in 1 liter (1000ml) of tap water. The bottom sample can be made by dissolving 31 grams of table salt (sodium chloride) in one liter (1000ml) of tap water.

Duplicate the activity pages. Provide one set per student.

OCEANOGRAPHIC INSTRUMENTS LAB



Van Dorn Bottle

Equipment:

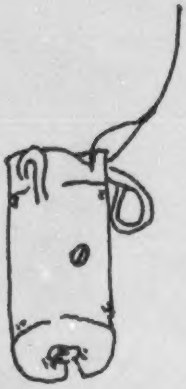
Van Dorn water bottle

Messenger

Water sample bottle

Procedure:

1. Cock Van Dorn bottle.
2. Attach to hydrowire.
3. Lower to approximately 1 meter in depth.
4. Trip bottle with messenger.
5. Raise Van Dorn bottle and pour sample into collection bottle.
6. Repeat above steps for a bottom sample.
7. Clean equipment and put away.



Messenger

KEY - Interpretation

Results depend upon the salinity of the solutions used.

1. The salinity estimates will most likely not be exactly the same.
2. There are many possible sources of this variation: errors in reading the hydrometer, errors in using the graph, use of the wrong solutions, differences between hydrometers, differences in the angle at which the hydrometer is viewed, etc.
3. Students will probably need help with the setting up of this problem. The answers will depend upon the salt solutions.
4. An estimate could be exactly the same, usually they are not.
5. Depends upon the results, usually the bottom sample will be more saline.
6. Answers depend upon the results, but both should fall within the given range.
7. Many things can help explain the range in salinities: fresh water inflows, rain water, evaporation, mixing, etc.
8. Lowest salinites would be found in areas with fresh water inflors, lots of rain and low evaporation rates. Temperate zones.
9. Highest salinities would be found in areas with low fresh water inflow, low rainfall and high evaporation rates. Tropical areas.

KEY WORDS

average

bouyancy

calculate

centigrade thermometer

diagram estimates

hydrometer

graduated cyclinder

parts per thousand (ppt or 0/00

residue

salinity

variation

volume

HYDROMETER SALINITY

You have seen that it is possible to determine the salt content, or salinity, of a water sample by evaporating the water from a known volume of salt water. The salt residue is then weighed. You have also seen what happens to an egg when you place it in fresh water and in salt water. Marine scientists use this buoyancy (floatation) information to determine salinity rapidly without evaporation.

The saltier the water, the higher something floats in it. Scientists use a weighted glass cylinder to determine salinity. The cylinder has a thin glass tube at the top with a scale printed inside (see diagram). The higher the salinity, the higher the tube floats and the larger the number that lines up with the water's surface. This instrument is called a hydrometer (hi-dram-a-ter).

You will be using a hydrometer to determine the salinity of salt water samples.

MATERIALS

Salt water solutions
Thermometer °C
Hydrometer
Temperature/salinity graph
500 ml graduated cylinder

METHOD

1. Fill graduated cylinder with 450 ml of your sea water sample.
2. Record water temperature with centigrade thermometer________.
3. Using the hydrometer, measure the density of your sample____ ________ HINT: The diagram will help you read the hydrometer.
4. Using hydrometer-temperature graph, read salinity ________0/00.

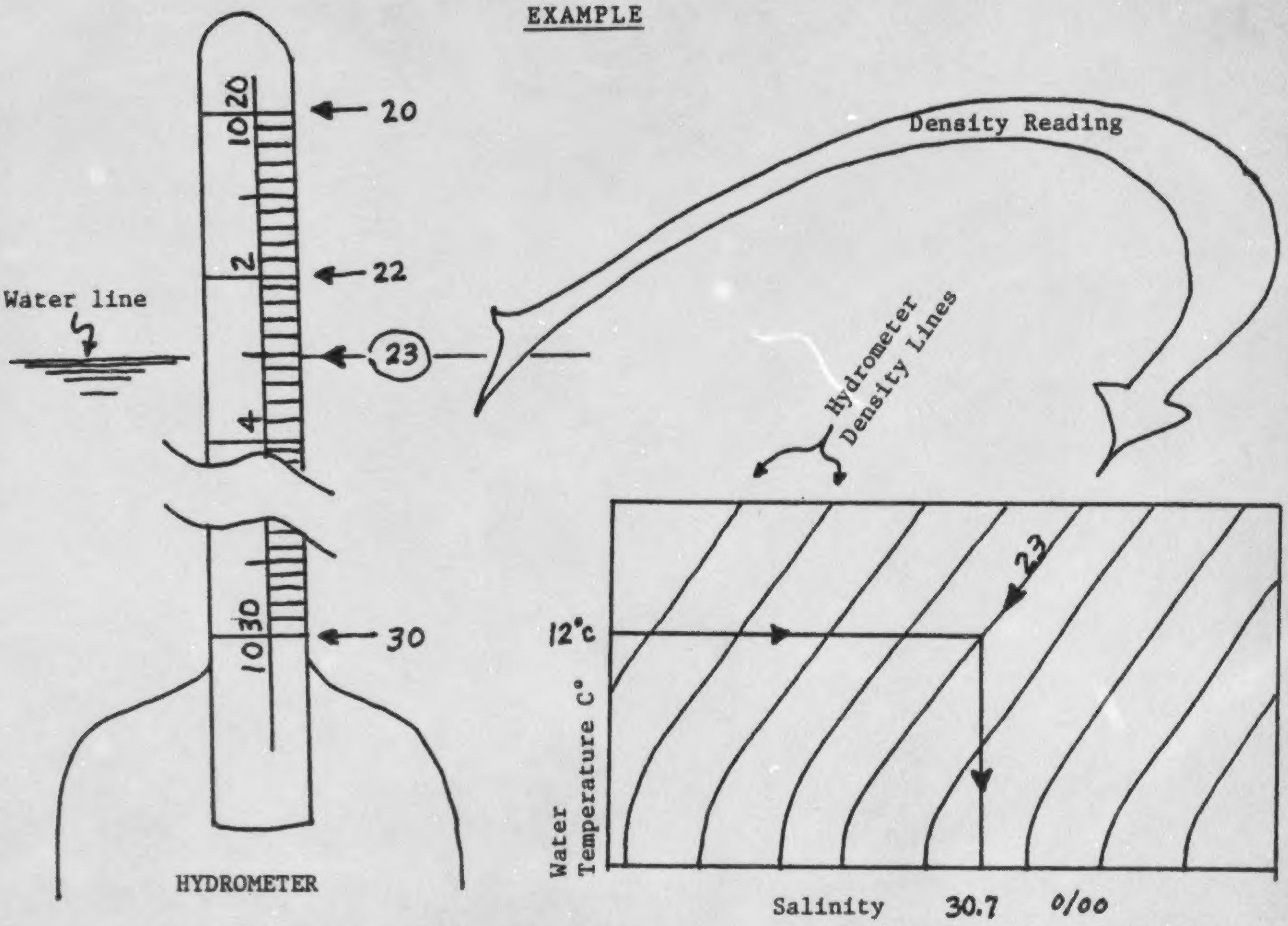
To Find Salinity:

a. Find correct water temperature on graph.

b. Follow temperature line over until you meet correct hydrometer density line.

c. From this point drop straight down and read off correct salinity of your sample in parts per thousand (0/00).

EXAMPLE


1020
20
2
22
Water line
23
4
1030
30
HYDROMETER
Density Reading
Hydrometer Density Lines
23
12°c
Water Temperature C°
Salinity 30.7 0/00

5. RECORD YOUR SALINITY ON THE BLACKBOARD as directed by your teacher.
6. Repeat the above steps for each salt solution provided.

INTERPRETATION

1. Look at the salinity determinations for salt solution number 1.
2. If you see differences in the estimates, list three possible sources of this variation.

    a) ______________________________

    b) ______________________________

    c) ______________________________

Scientist have found that they can obtain more accurate results if they repeat a procedure several times and take an average. The average figure that they obtain has a better chance of being the real (correct) figure than any of the individual figures do.

3. Calculate the average salinity for each of the salt solutions tested. (Hint: this is easy! Take all of the salinity estimates for a given solution and add them together. Divide this sum by the number of estimates. The answer is your average. In other words,

$$\frac{\text{sum of salinity estimates (solution X)}}{\text{number of salinity estimates (solution X)}} = \text{average salinity estimate for solution X}$$

4. Are any of the estimates on the board exactly the same as the calculated average?______________________________________

5. Which solution was the saltiest? __________________________

6. The salinity of sea water ranges from about 25 parts salt/per thousand parts of water (25 ppt) to about 34 parts per thousand. Did either or both solutions fall in this range? If yes, which ones?____

____

7. What are two conditions that might help account for a range (from 25 ppt to 34 ppt) in ocean salinities rather than a single uniform salinity?

    a) ____

    b) ____

8. Where would you expect the lowest salinities to be found? Explain.

____

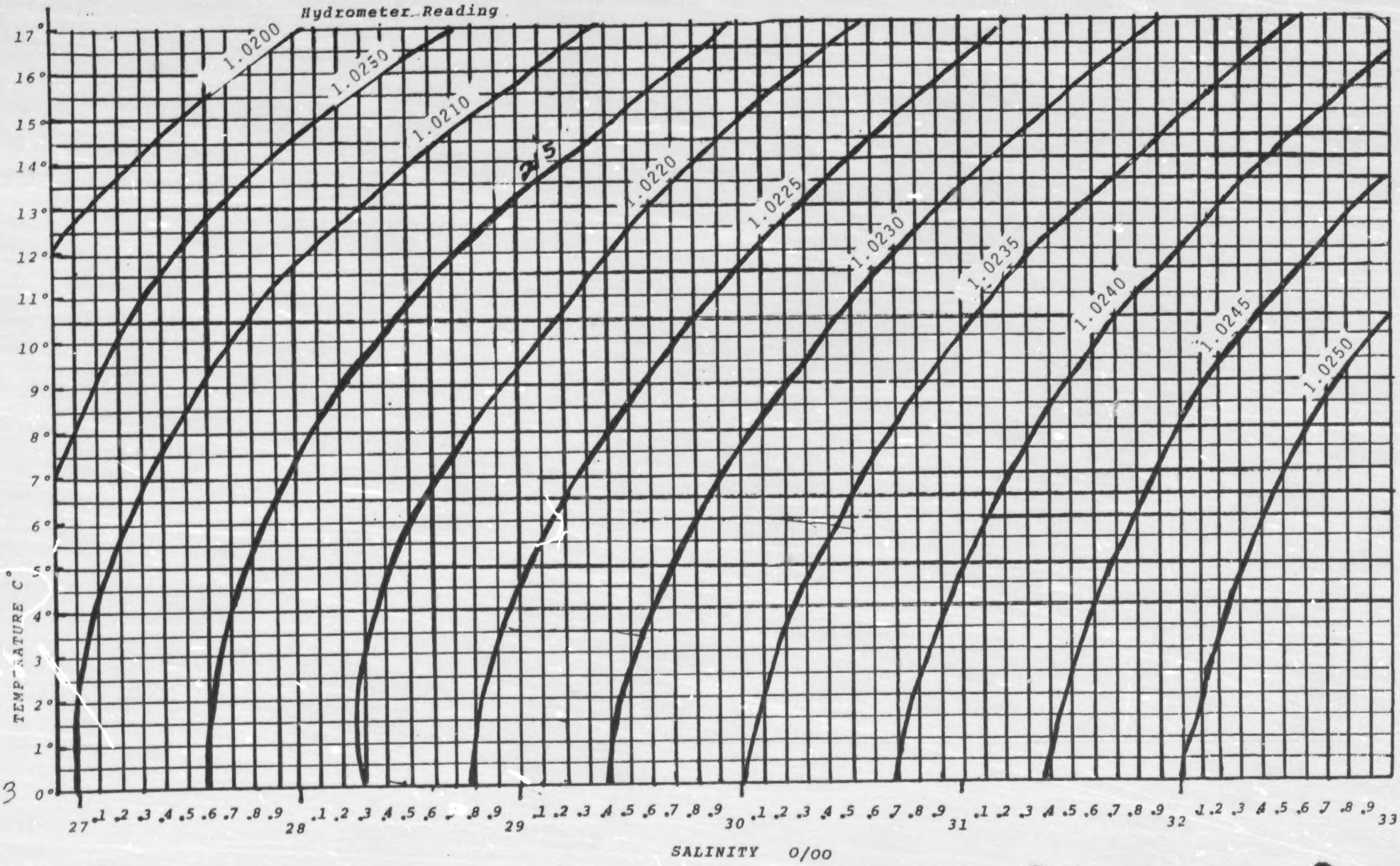
____

____

9. Where would you expect the highest salinities to be found? Explain. ____

____

____


Hydrometer Reading
1.0200
1.0250
1.0210
215
1.0220
1.0225
1.0230
1.0235
1.0240
1.0245
1.0250
TEMPERATURE C°
17°
16°
15°
14°
13°
12°
11°
10°
9°
8°
7°
6°
5°
4°
3°
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27 .1 .2 .3 .4 .5 .6 .7 .8 .9 28 .1 .2 .3 .4 .5 .6 .7 .8 .9 29 .1 .2 .3 .4 .5 .6 .7 .8 .9 30 .1 .2 .3 .4 .5 .6 .7 .8 .9 31 .1 .2 .3 .4 .5 .6 .7 .8 .9 32 .1 .2 .3 .4 .5 .6 .7 .8 .9 33
SALINITY 0/00

163

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TEACHER BACKGROUND - What's That Sound?

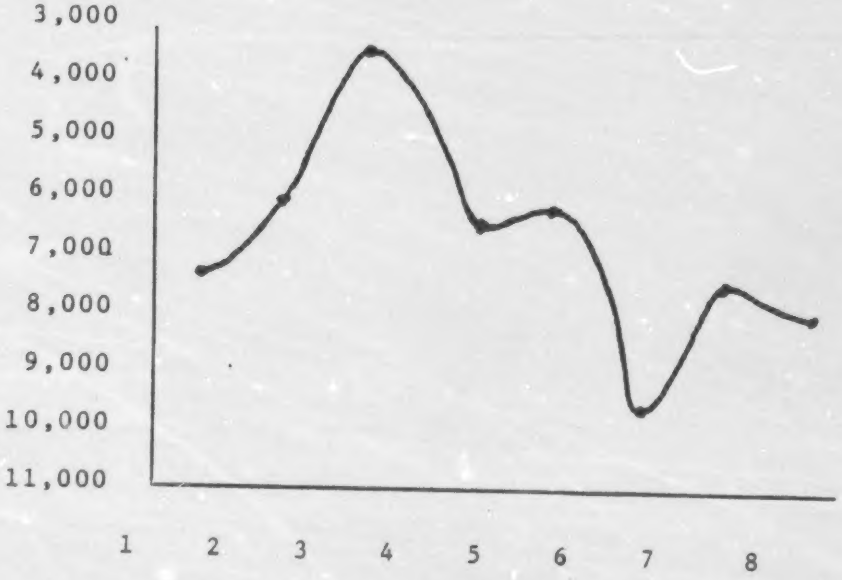
This activity examines echo sounding, a technique used to determine the bottom contours of the ocean.

Duplicate the activity pages. One set per student. The mathematics are relatively simple, but some students will need help in getting the problems set up. Some may need a refresher course in plotting data points.

KEY - table, graph, and interpretation

Station No.	Time down & back (sec)	Depth (feet)
1	3.0	7,500
2	2.5	6,250
3	1.5	3,750
4	2.8	7,000
5	2.7	6,750
6	4.0	10,000
7	3.1	7,750
8	3.3	8,250

OCEAN DEPTHS ALONG PATH OF THE R/V Nordic Maid.



Interpretation

1. Seamount or undersea mountain
2. Ocean trench or undersea valley
3. The false bottom can be used to locate schools of fish.
4. Help locate fish, Keep gear from fouling on bottom, keep boat from running aground etc.

KEY WORDS

data

echo sounders

phenomena

plot

points

profile

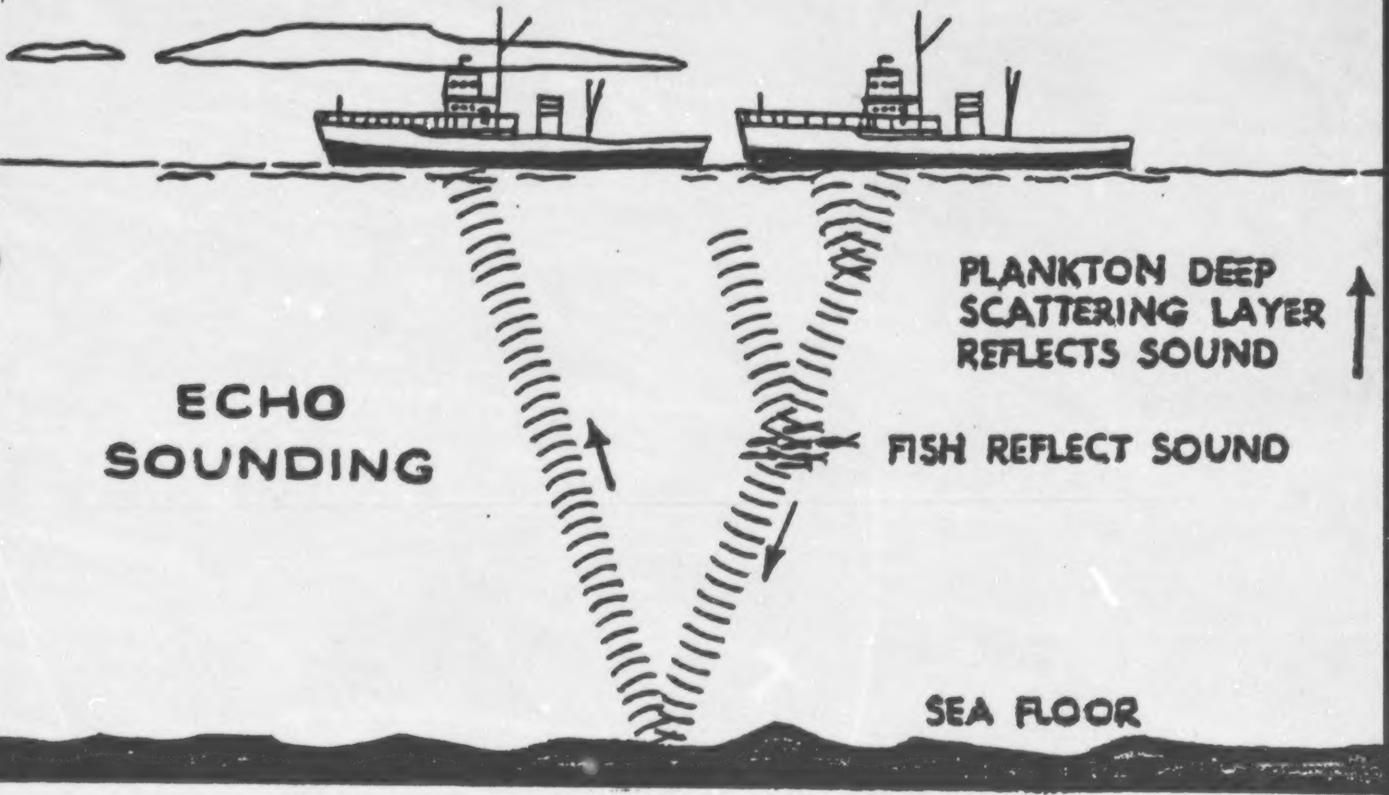
reflect

sonar ping

sounding

WHAT'S THAT SOUND?

Sounding the ocean depths means measuring how deep the water is at a given point. For years the standard method for sounding involved letting a marked line with a weight on the end over the side of the boat. The depth was recorded when the weight hit the bottom. Today echo sounders are used to determine depth. Echo sounders bounce sound off of the bottom of the ocean. We know how fast sound travels in water. We can determine the depth by knowing how long it takes for sound to go from the boat to the bottom and back to the boat.



Sound travels faster in water than it does in air. In water sound travels at the rate of 5000 feet per second or in meters it could be written as 1500 meters per second. (5000 ft./sec.= 1500 m./sec.) In the picture above the sonar ping is traveling from the ship to the bottom and back to the ship at the rate of 5000 ft./sec. If the bottom were 250 ft. down and 250 ft. back for a total of 500 ft. This would take the sonar ping 1/10 of a second to travel this distance.

$\text{Time} = \frac{\text{total distance down and back}}{5000 \text{ ft. / sec.}}$ or $\text{depth} = \frac{\text{time down and back X } 5000}{2}$

The R/V Nordic Maid is cruising due north mapping the ocean bottom. The time it took for a sound wave to travel from the boat to the bottom and back to the boat is given for each of eight stations sampled.

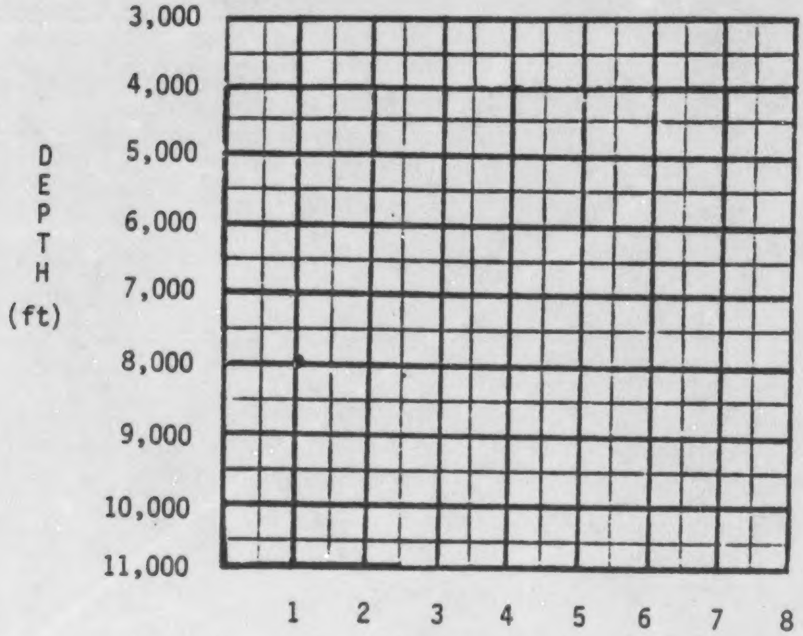
Use this data to determine the depth of the ocean along the route of the R/V Nordic Maid.

Station No.	Time down & back (sec)	Depth (feet)
1	3.0	$\frac{3 \text{ sec} \times 5000 \text{ ft/sec}}{2} = 7{,}500$ ft.
2	2.5	
3	1.5	
4	2.8	
5	2.7	
6	4.0	
7	3.1	
8	3.3	

Now you have some figures for depths. Let's plot these figures to see what a profile of the bottom would look like. The bottom of the graph shows the station numbers. The left hand side of the graph gives the ocean depth. Find the station number you wish to plot and move up the graph directly above the station number until you reach the depth determined for that station. For example, station 1 was 7,500 feet deep. Look at the graph and see that the dot above station 1 is at the level of 7,500 foot depth.

Plot the depths at stations 2 to 8. After you have plotted the depths connect the points (dots) with a smooth pencil line. This line reflects the shape of the ocean bottom along the path of the R/V Nordic Maid.

OCEAN DEPTHS ALONG THE PATH OF THE R/V NORDIC MAID



STATION NUMBER

INTERPRETATION

1. What is the ocean feature seen at station 3?________________

2. What is the ocean feature seen at station 6?________________

3. If a school of fish is present under the R/V Nordic Maid, the echo sounder will show a "false bottom" where the school of fish is located. How might this "false bottom" phenomena be of use to fishermen? ____________________________

____

4. What are two reasons many fishermen have echo sounding equipment on board their boats?

a. ____

b. ____

BEACH ENVIRONMENTAL CONDITIONS

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TEACHER BACKGROUND - The Beach and Around the Beach

The next four activities deal with beach environmental conditions. "The Beach" serves as an introduction to the topic. "Around the Beach" is a puzzle to review the material in "The Beach." These two activities should be performed simultaneously.

Beach Environmental Conditions

The movement of ocean waters (tides, waves, and currents has little effect upon organisms beyond the intertidal zone. Animal life is bound pretty closely to its food supply. Since coastal areas support most sea life, we find the environmental factors of water movement most significant in shallower depths. Therefore, tidal organisms have the "pressures" of exposure, immersion, abrasion, insolation, varying temperatures and salinities which animals of the deep sea do not have.

Animals at the edge of the sea on rocky or sandy shorelines depend upon the tides for their way of life. Tide is the name given to the daily shifting of the earth's waters in a rising and falling, or in and out motion over the land at the water's edge. During its rise, the tide is called flood-tide, during its fall, ebb-tide. Twice each month, soon after the new moon and the full moon, the sun and moon join forces in pulling at the earth and its waters. This pulling creates unusually high and low tides which are called spring tides. The name spring tides does not refer to a season of the year, but to the "springiness" or fullness of the tides.

When the moon is at the first or third quarter the water neither rises as high nor falls as low as on the spring tides. These tides, in which there is not much difference between the high and low tides, are called neep tides.

SUMMARY: Beach Environmental Conditions

A. Upper Beach (Supera-Littoral Beach)

1. Water in the form of spray except in case of extreme high tide.
2. Animals exposed to air rather than water.
3. Extreme temperature changes (below 32^{o}F to excess of 90^{o} F).
4. Drift logs, sticks, kelp, etc.
5. Decayed matter washed up on beach.

B. Middle Beach (Littoral Beach)

1. Covered with water twice every 24 hours.
2. Exposed to air and atmospheric conditions twice every 24 hours.
3. Water temperature varies greatly according to season as well as night and day.
4. Beach temperature varies greatly.
5. Attached animals are exposed to atmospheric conditions some of the time and under water some of the time.

C. Lower Beach (Sub-Littoral Beach)

1. Covered by water except in case of extreme low tides (minus tides)
2. Water temperature is much more stable than in the above two areas.

Duplicate the reading pages for "The Beach". One set per student. Duplicate the puzzle "Around the Beach". One per student. Students may work individually or in small groups as you desire. It is best to allow some time for student reading of the text pages after an initial introduction to the topic of the beach. Devote a few minutes to summary discussion while reviewing correct answers.

KEY - Around the Beach

See next page for completed puzzle.

KEY WORDS

adaptation

alternately

barnacles

decayed

ebb tide

organisms

evaporate

exposed

flood tide

habitats

intertidal zone

littoral beach

organism

salinity

scavengers

sub-littoral beach

submerged

supra-littoral beach

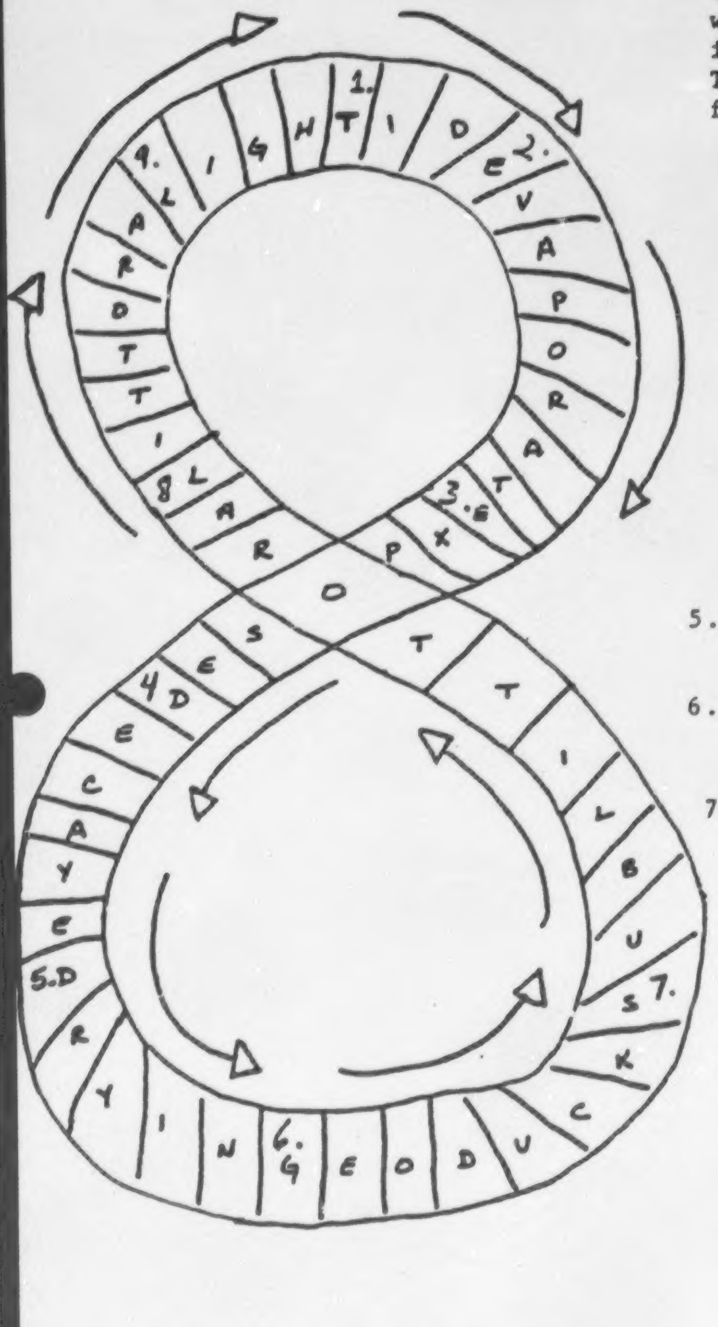
tide pools

tides

zone

TEACHER BACKBROUND - KEY

AROUND THE BEACH



Write the first letter of word# 1 in box #1. Then write the rest of the word in the direction shown by the arrow. Do the same for each word. The last letter of each word is the first letter of the next word. The last letter of word # 9 is the first letter of word # 1.

1. The daily shifting of the earth's waters in a rising and falling motion over the land is called TIDE.

2.. Water in tide pools will warm and the water will go off as vapor or EVAPORATE.

3. The intertidal zone is the area tha is alternately submerged then EXPOSED.

4. There is lots of DECAYED matter to eat in the upper beach zone.

5. Sun and salt have a DRYING effect on living things.

6. In the lower beach zone you can find many of these giant clams or GEODUCKS.

7. The SUBLITTORAL beach zone is covered by water except in the case of extreme low tides.

8. Animals and plants living in the LITTORAL beach zone are covered with water except in the case of extreme low tides.

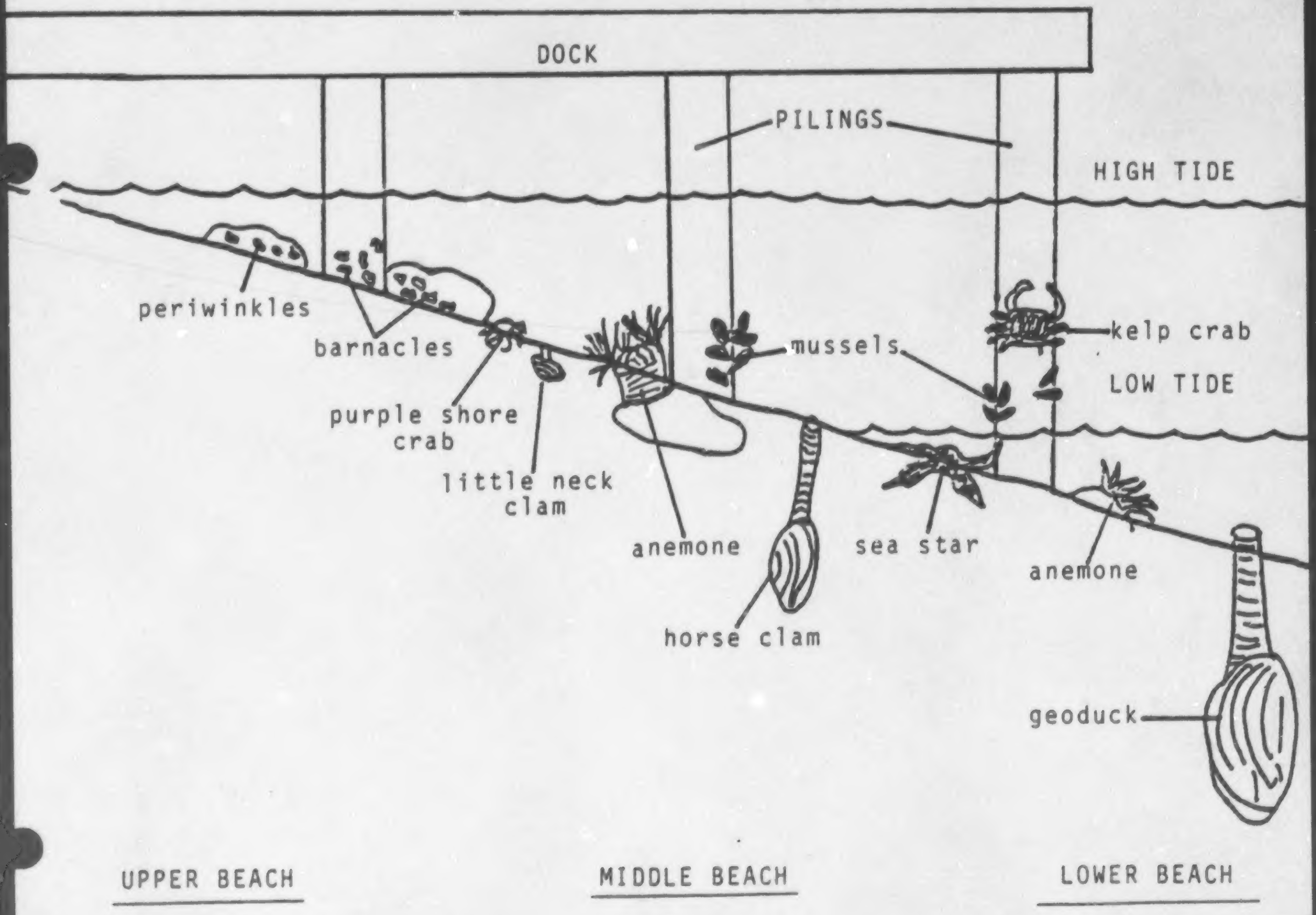
9. The intertidal zone is shallow enough to let LIGHT from the sun reach the bottom.

THE BEACH

The seabeach is a place of change. Daily the waters at the edge of the beach move in and out. The waves pound at the edge of the sea. Sun dries the exposed areas. Organisms, plants and animals, that live at the edge of the sea must deal with all of these changes.

Tide is the name given to the daily shifting of the earth's waters in a rising and falling motion over the land at the water's edge. During its rise, the tide is called flood tide, during its fall, ebb tide. Animals and plants at the edge of the sea on rocky or sandy shorelines depend upon the tides for their way of life.

A TYPICAL BEACH IN CROSS SECTION


DOCK
PILINGS
HIGH TIDE
periwinkles
barnacles
purple shore crab
little neck clam
anemone
mussels
kelp crab
LOW TIDE
horse clam
sea star
anemone
geoduck
UPPER BEACH
MIDDLE BEACH
LOWER BEACH

Let's start out in the deep waters of the ocean and see how the tides affect living things. Beyond the intertidal zone (the beach area that is alternately submerged then exposed) tides have little effect upon organisms.

Within the Intertidal zone, the lower beach area is covered by water except in the case of extreme low tides. What is it like to live in the lower beach or sub-littoral beach? The water above you is in gentle motion. You seldom even feel the effects of storms. Except for currents, you hardly need to worry about holding on to the bottom. The temperature of the water is usually constant, changing little. The moving waters bring you lots of things to eat. Who are you? You might be a sea urchin, a purple starfish, geoduck (goo-e-duck) clam, or a sea cucumber.

The middle beach, or littoral beach, is a very different place to live. Living in the middle beach, you are covered with water twice every 24 hours. This also means, of course, that you are uncovered twice every 24 hours. During these uncovered periods you are exposed to the air and its drying power. The sunlight tries to dry you. The water temperature changes as the water moves back and forth across the heated beach. This is a tough place for you to live. In and out of the water, wet and dry, hot and cold.

As the water left behind in tide pools begins to warm and evaporate, the salinity or salt content of the pools goes up. Now salinity tries to dry you out. How can you deal with these changes?

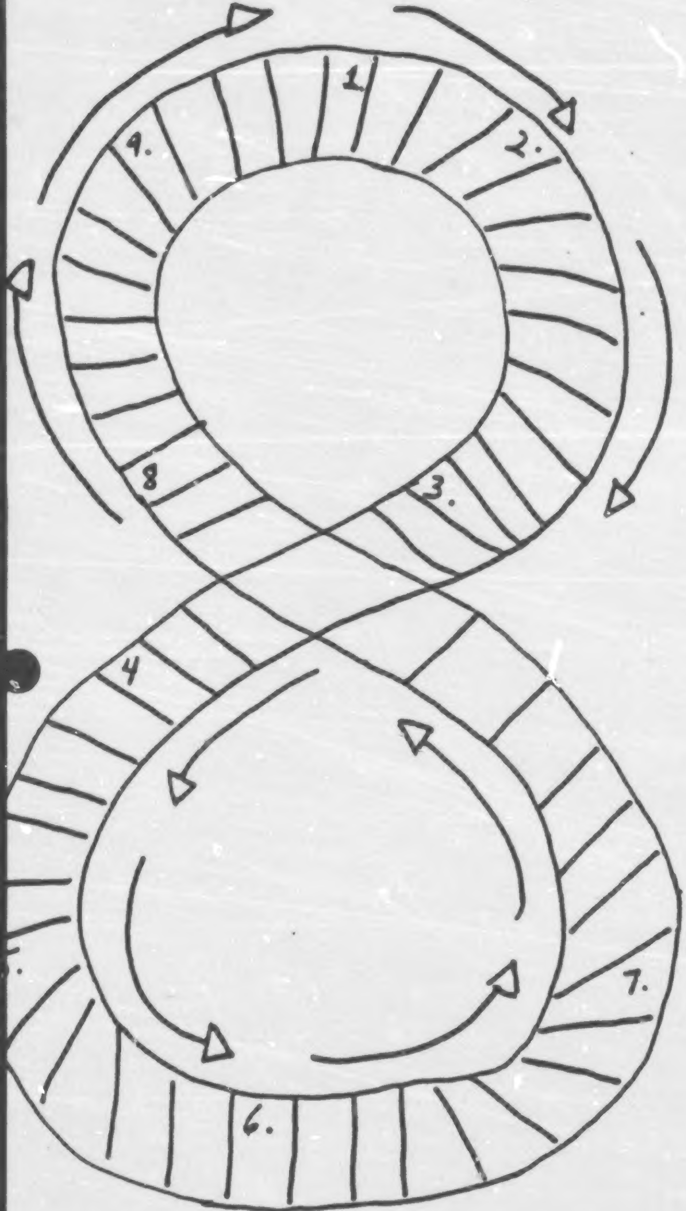
Animals in this zone have special adaptations to help them survive these changes. Some animals elect to avoid the changes.

Barnacles, for example, close up shop and sit inside their houses during the dry period of the day. Shore crabs, move under rocks to hide from the drying sun. The surf and waves pound on you as the tide moves in and out. To avoid being damaged some animals are flattened, others have hard shells. This is a harsh place to live but there is lots of food. Who are you? You might be a horse clam, anemone, mussel, little neck clam, purple shore crab, or barnacle.

The upper beach, or supra-littoral beach, is more land than water. Except for extremely high tides, this area only receives water in the form of spray. Here, you are exposed to air rather than to water. The temperature changes are even greater than in the middle beach zone. The area is covered with drift logs, sticks and drying seaweed. There is lots of decayed matter washed up on the beach to provide food for scavengers. What do you find living here? Periwinkles, a kind of snail, live in this zone. Limpets with a single pointed shell are also found here. Limpets can attach themselves to the rocks, to avoid drying between high tides, they keep a little water inside the shell with them. You would also find yourself in the company of several kinds of barnacles. The barnacles can avoid drying by closing their shell opening. This is a zone that looks lifeless until you begin to move rocks and driftwood aside. There is lots of life in the supra-littoral beach.

The sea beach provides many unique habitats or homes for animals and plants. When you go to the beach look for the different organisms in these three zones. Always replace the animals and plants where you found them. They have a tough enough life already. Thanks.

AROUND THE BEACH



Write the first letter of word #1 in box #1 Then write the rest of the word in the direction shown by the arrow. Do the same for each word. The last letter of each word is the first letter of the next word. The last letter of word #9 is the first letter of word #1.

1. The daily shifting of the earth's waters in a rising and falling motion over the land is called ______________.

2. Water in tide pools will warm and the water will go off as vapor or ________________.

3. The intertidal zone is the area that is alternately submerged then ______________ .

4. There is lots of __________matter to eat in the upper beach zone.

5. Sun and salt have a ___________effect on living things.

6. In the lower beach zone you can find many of these giant clams or ____________.

7. The _______________ beach zone is covered by water except in the case of extreme low tides.

8. Animals and plants living in the _____________ beach zone are covered with water twice every 24 hours.

9. The intertidal zone is shallow enough to let _______________from the sun reach the bottom.

TEACHER BACKGROUND - Beach Creatures

This activity uses the information presented in "The Beach" to examine some structures and behaviors that help beach animals survive.

Students will need to have their copies of "The Beach" handy to answer the questions in this activity.

Duplicate the pages of the activity. One set per student.

Students may work individually or in small groups. They may also work individually then in small groups. Your particular circumstances will dictate which plan is best for your class.

Allow some time for discussion and review of the correct answers.

KEY - questions

1 The periwinkle only has to worry about getting wet during extremely high tides and from spray.

2. The periwinkle might eat decayed matter.

3. The periwinkle can withdraw into its shell and seal off the entrance to avoid drying.

4. The eyes act like a periscope and allow better vision while still keeping the animal in a low profile.

5. The cirri are used like brushes to sweep the plankton, to catch it and to pass it to the mouth.

6. Lots of things change: air temperature, water temperature, amount of sunlight, drying and wetting conditions, food supply, salinity.

7. The barnacle is covered with water twice every 24 hours, it also dries out twice every 24 hours.

8. The barnacle can avoid being tossed around by the wave action as the tide moves in and out. This lets the barnacle remain in a favorable location.

9. The barnacle closes up shop and retains moisture inside the shell.
10. The sea star has to worry about drying out only during the very lowest tides.
11. At low tide, the sea star would need to avoid being washed away by wave action. Low tide would also make it vulnerable to predation by birds. Therefore, one might make a good case for the holding power being more important at low tide.
12. I would travel during the high tide to avoid drying out.
13. Upper beach: limpets, barnacles

    Middle Beach: horse clams, anemones, mussels, little neck clams, purple shore crabs

    Lower Beach: geoduck, anemone, kelp crab

KEY WORDS

barnacle

behavior

cirri

littoral beach

microscopic

periwinkle

plankton

sea star

structure

sub-littoral beach

supra-littoral beach

survive

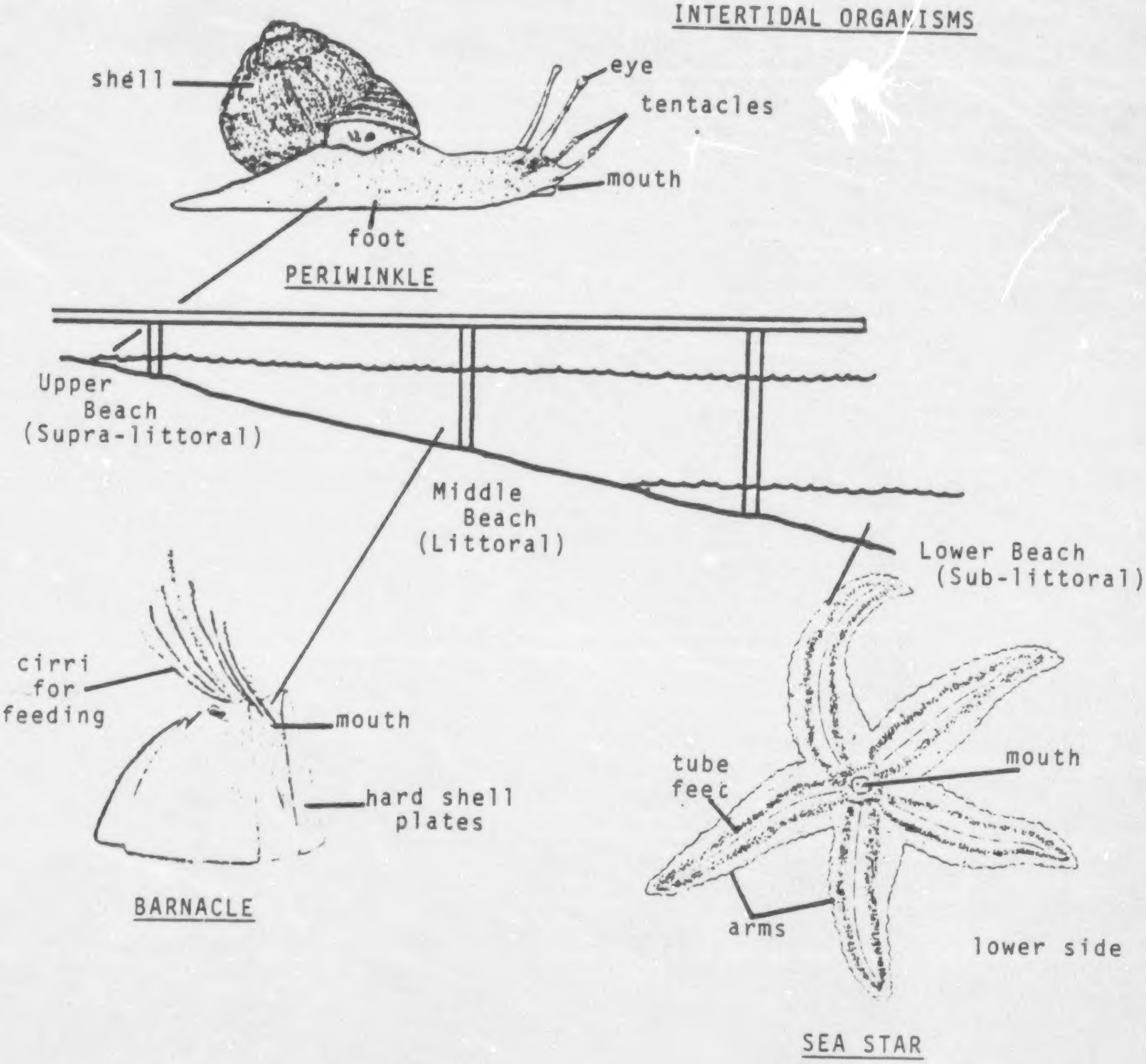
tidal day

tube feet

BEACH CREATURES

The animals of the intertidal beaches have developed special structures and behaviors to help them survive. The three animals shown below live in the three intertidal zones discussed in "The Beach" Use the information in the discussion to answer the following questions.

INTERTIDAL ORGANISMS


shell
eye
tentacles
mouth
foot
PERIWINKLE
Upper Beach (Supra-littoral)
Middle Beach (Littoral)
Lower Beach (Sub-littoral)
cirri for feeding
mouth
hard shell plates
BARNACLE
tube feet
mouth
arms
lower side
SEA STAR

Supra-littoral beach

The periwinkle lives in the upper beach zone.

1. When does the periwinkle have to worry about getting wet? _______

____

2. What might the periwinkle eat? ____________________

____

3. How might the periwinkle use its shell to avoid drying out? ____

____

4. What might be an advantage of having your eyes on a stalk like the periwinkle's? ______________________________

____

Littoral beach

5. The barnacle eats microscopic plants and animals called plankton. How might the cirri be used for feeding upon these small organisms?

____

____

6. What are three conditions in the barnacles's surroundings that change with the rise and fall of the tides?

   a. ____________________________________

   b. ____________________________________

   c. ____________________________________

7. How many times is the barnacle covered with water during the course of a day? How many times do they dry out? ____________________

____

8. The barnacle is capable of gluing itself to a surface in the middle beach zone. How might this behavior help the barnacle to survive? ____________________

____

9. How does the barnacle avoid drying out during the times the tide is out? ____________________

____

____

Sub-littoral beach

10. When does the sea star have to worry about drying out? ____________________

____

11. The sea star has arms with many small tube feet which help the sea star to hold on to the bottom. When would it be most important for the seastar to be able to hold on?, at high tide or at low tide? Explain. ____________________

____

____

12. Seastars are fond of mussels. Since mussels are often found higher up on the beach, the seastar has to travel for his meal. During the course of the tidal day, when would you travel if you were a seastar? Why then? ____________________

____

13. For each of the three beach zones, name one additional organism that might be found living there.

a. ____________________

b. ____________________

c. ____________________

TEACHER BACKGROUND - Design A Winner

This is a fun change of pace activity. Creative thinking can manifest itself in this exercise. Interestingly enough, the most bizarre features students design usually can be found in nature!

Duplicate the activity. One per student. If necessary, provide additional paper, and pencils. Try not to do the designing. You can emphasize the problems of life which the designs are to solve (protection, etc.) Be sure students label the adaptations and name the creature. Post the drawings on a classroom bulletin board.

KEY WORDS

adaptation

organism

salinity

DESIGN A WINNER

Organisms that live at the edge of the sea face many problems. We've seen that they have to deal with: the pounding waves, drying out, temperature changes, salinity changes, and finding food. Each plant and animal has special adaptations to help it survive. Here is your chance to take all of those special adaptations and combine them in a creature of YOUR DESIGN! In the space below, draw your animal. Be sure to label its adaptations and to give it a name. Use the successful, living organisms mentioned in "The Beach" for hints.

THE BIOLOGICAL ENVIRONMENT

TEACHER BACKGROUND - The Biological Environment

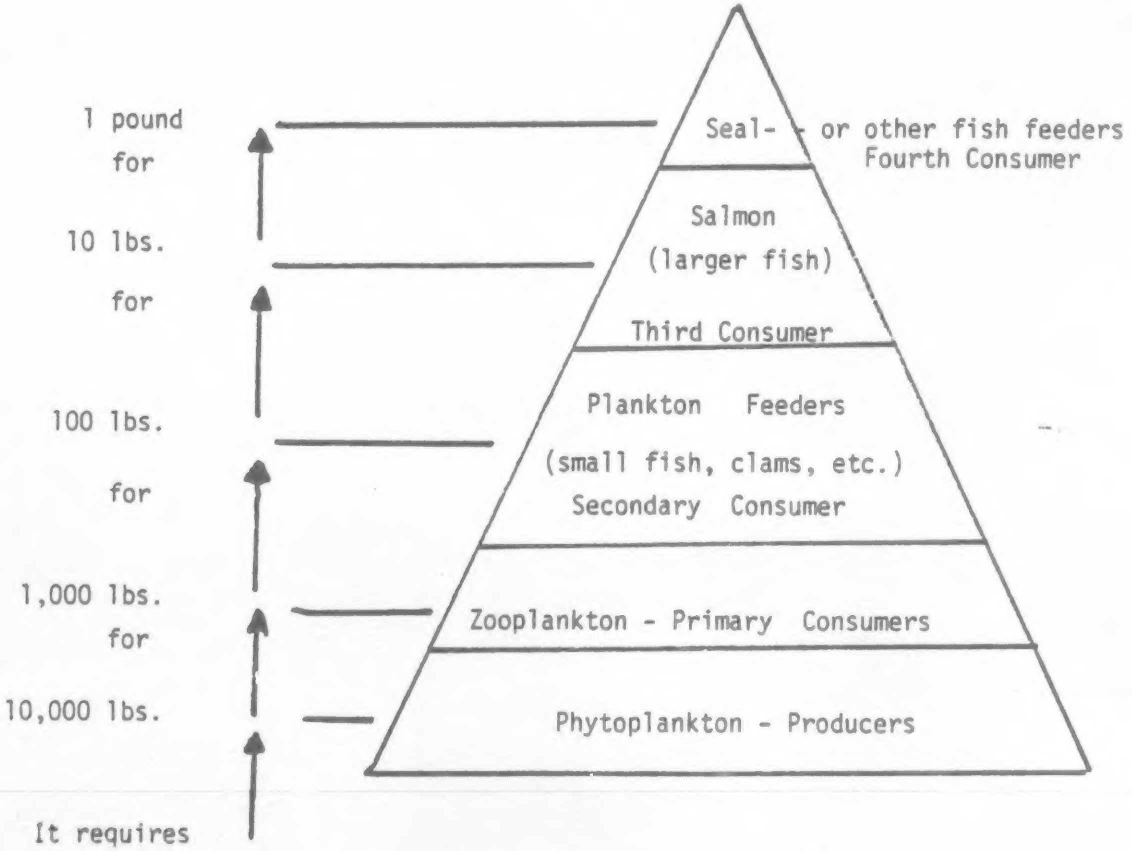
The next six activities deal with the biological environment. We have seen the effect of the non-living environment on living organisms. In these activities, we focus on the interactions between living organisms.

Plankton are those forms of plant and animal life that are drifters and are at the mercy of the currents for locomotion. These planktonic organisms are sometimes called the "grass of the sea". For they are the free floating, largely microscopic, plants and animals that, among other things, are responsible for the colors of the sea. When you see clear blue water it indicates an ocean desert, or the lack of planktonic life.

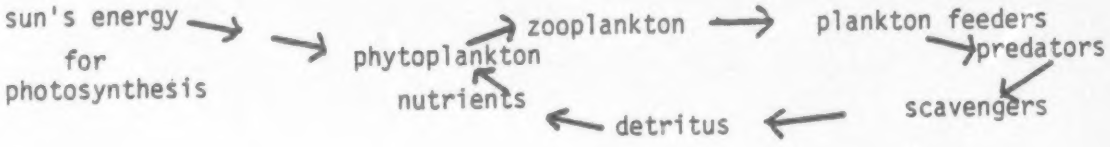
The two major divisions of plankton are the plant plankton or phytoplankton and the animal plankton or zooplankton. The phytoplankton are dependent upon sunlight for survival, since they are the photosynthetic organisms, or primary producers. The zooplankton are basically dependent upon the phytoplankton as a source of food, however some forms of zooplankton may eat smaller forms of zooplankton. Zooplankton may be either temporary plankton or permanent plankton. Temporary plankton are larva of marine animals or fishes, where the animal spends only part of its life span as plankton. When the organism extends its entire life period in the plankton world it is a permanent zooplankton.

Planktonic diatoms, one form of phytoplankton, make up the bulk of the plankton population. Diatoms are so minute that millions may exist in as little as a gallon of sea water. By using the sun's energy for photosynthesis in making their own food, diatoms form the first link in almost every food chain in the sea. Diatom production may reach staggering levels during brief blooming periods when currents in the water stir up nutrients. Populations as high as 72 million per cubic foot of sea water have been reported. Diatoms can divide into two new cells every twenty-fours. Under such conditions the zooplankton, which depend upon these phytoplankton as a source of food, also increase in number. As many as 3000 different kinds of zooplankton larva have been found in as little as a quart of sea water.

A single copepod, a form of zooplankton, can have more than 120,000 diatoms in its stomach at one time. In turn, a small fish such as a herring or smelt might be able to collect 50,000 copepods in a very short ime, only to find himself eaten by an even larger predator. This builds a food pyramid effect.


1 pound
for
10 lbs.
for
100 lbs.
for
1,000 lbs.
for
10,000 lbs.
It requires
Seal- or other fish feeders
Fourth Consumer
Salmon
(larger fish)
Third Consumer
Plankton Feeders
(small fish, clams, etc.)
Secondary Consumer
Zooplankton - Primary Consumers
Phytoplankton - Producers

Food pyramids, like the above, make up a segment of a food chain where one animal eats another animal which is eaten by still another animal. Food chains can be very short or quite long, depending upon the number of different animals involved in completing the cycle. The complete cycle results in animal decay being decomposed by bacteria which in turn will supply the phytoplankton with nutrients or food material.


sun's energy
for
photosynthesis
phytoplankton
zooplankton
plankton feeders
predators
scavengers
detritus
nutrients

- Food chain -

Almost every animal eats more than one kind of food source and, in turn, may be eaten by several different kinds of animals. This interlocking pattern of food chains is known as the food web.

Summary Outline - The Biological Environment

I. Plankton - any form of drifting plant or animal life in the sea, regardless of size.

   A. Phytoplankton - plant forms of plankton

      1. Diatoms - minute single celled plant forms which are able to use the sun's energy to convert nutrients into food.

      2. Dinoflagellates - much like diatoms but possess characteristics of both plants and animals (manufactures food through photosynthesis, but moves like an animal) Some species of Dinoflagellates are responsible for red tides.

   B. Zooplankton - animal forms of plankton

      1. Temporary zooplankton (larval forms) - the larval stage of marine animals and fishes; animal spends only part of its life as plankton. It is important to note that almost all of the life forms in the sea are at one time plankton.

      2. Permanent zooplankton - the animal form of plankton which spends its entire life as a plankton

II. Plankton populations - depend upon light penetration and nutrients in the sea.

   A. Quantity - as many as 72 million diatoms per cubic foot of water

   B. Variety - as many as 3000 different kinds of zooplankton may be found per quart of water

III. Investigations into plankton food cycles

   A. investigate food pyramids

   B. Investigate food chains

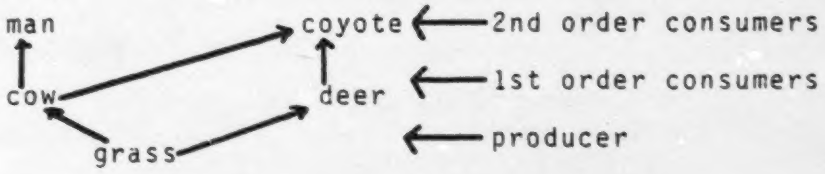
   C. Investigate food webs

Duplicate the reading pages. One set per student.

This activity may be done individually. It may also be spread out over two days. This section provides a foundation for the other activities in The Biological Environment. It is important for students to understand the concepts of food chain and food web. Take the time to help develop these ideas.

KEY - questions

1. Microscopic means very small, unable to be seen without the aid of a microscope.
2. Plankton are free floating organisms which are carried by the water movements.
3. The two different kinds of plankton are phytoplankton and zooplankton (plant and animal plankton)
4. Plants are called producers because they store energy and produce food for other creatures.
5. Phytoplankton are the major producers in the ocean community.
6. The answer depends upon the student's experience. Check to see that the food chain is logical.
7. Refer to number 6.
8. A possible food web from the organisms given.



9. See number 8.

10. In this web, no animal is both a first order and a second order. If the cayote was considered to eat grass, it would be both a first order and second order consumer. In real life, they seldom eat grass.

11. The small fishes are eating zooplankton and phytoplankton.

12. Small fishes and plankton-feeding whales and sharks are both first and second order consumers.

13. The chain:

zooplankton → small-fishes → medium fishes → large fishes → fish feeding sharks

sharks makes the fish feeding sharks fifth order consumers.

14. The whale shown is a first order consumer when it eats the phytoplankton, an a second order consumer when it eats the zooplankton.

15. $$\frac{\text{10,000 pounds of producer}}{\text{pound of 4th consumer}} \times \frac{\text{2,000 pound 4th consumer}}{1} = 20{,}000{,}000\ \#$$ of producer necessary to make a 1 ton 4th order consumer.

16. Without phytoplankton, we would have no fish to eat. Phytoplankton are the foundation of the food pyramid of the ocean.

KEY WORDS

consumers

dependent

energy

first order consumer

food chain

food web

gulfweed

indirectly

isolate

KEY WORDS CONTINUED

links

microscopic

organism

phytoplankton

producers

pyramid of numbers

second order consumers

third order consumers

ultimately

zooplankton

Some of the material which follows is adapted from the Florida 4-H Marine Program pamphlet "Plankton - The Basis of Life" by Mrs. Carolee Parmer.

THE BIOLOGICAL ENVIRONMENT

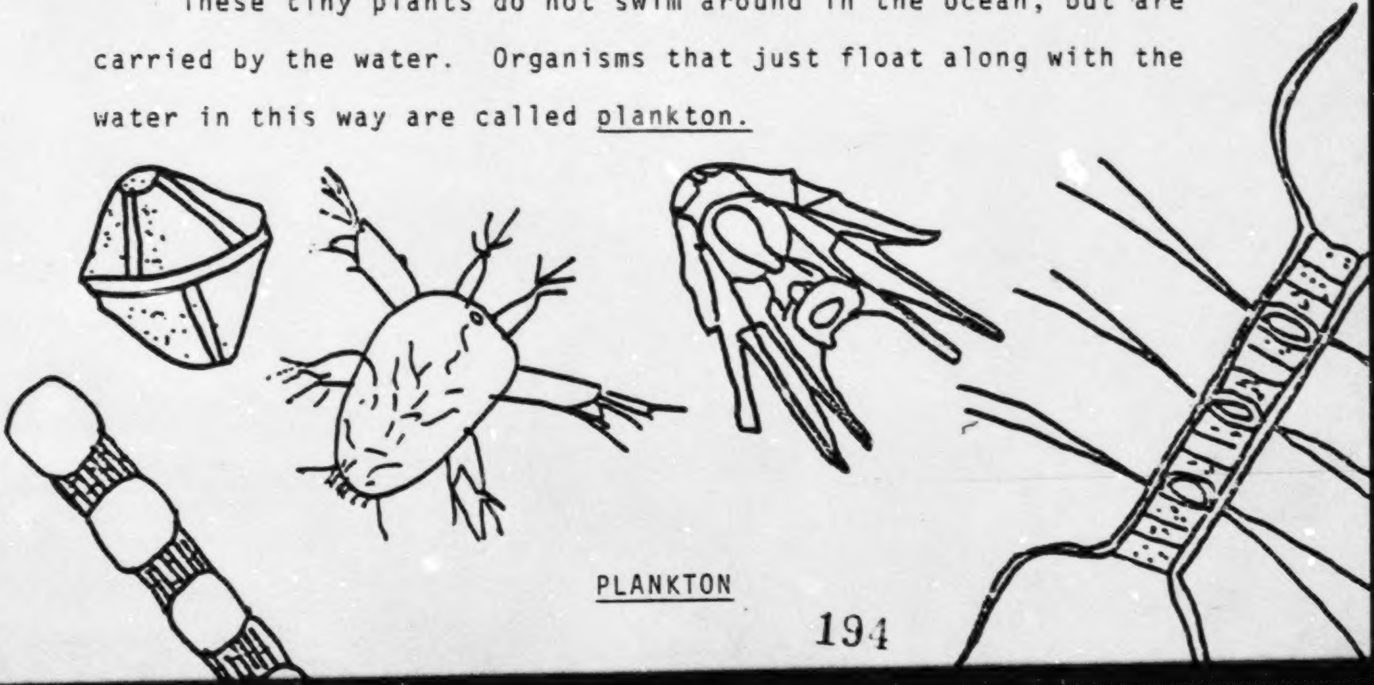
Look outside. See all the green plants? What if they all suddenly came up-rooted and flew up into the air to grow there instead of on the ground? Then cows and horses and all the other animals that eat plants would have to chase the plants around in the air to get anything to eat.

Sounds silly, doesn't it? But there is one place on Earth that is very much like this. Plants and animals float about and are not confined to the Earth's surface. That place is the ocean.

The Sea Garden

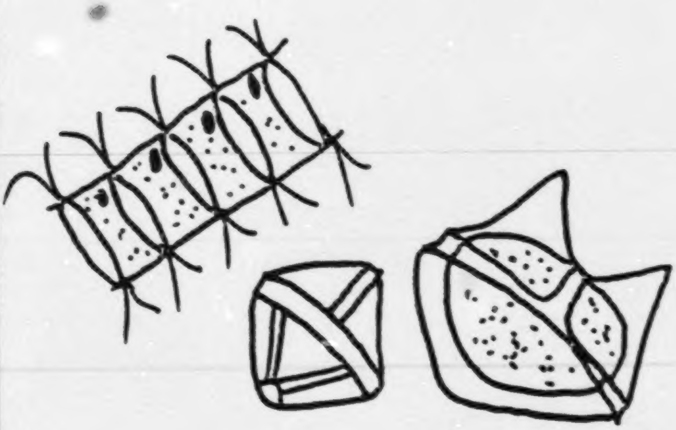
In the ocean, some plants are fastened to a rock or the sand, and look much like land plants. Many more of them are too tiny to see without a microscope, and float freely in the water. Organisms that are this small some times have only one cell, and are called microscopic. This great mass of microscopic plants floating in the water is the garden of the sea. It is the place where all marine (ocean-dwelling) life, either directly or indirectly, gets its food.

These tiny plants do not swim around in the ocean, but are carried by the water. Organisms that just float along with the water in this way are called plankton.

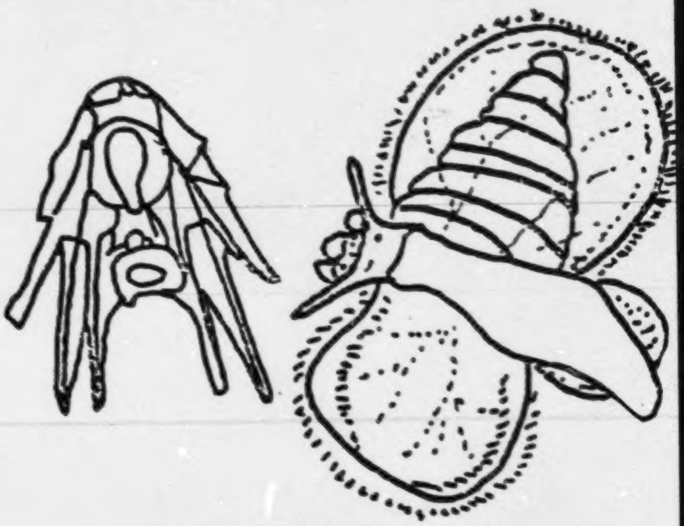


PLANKTON

Two different kinds of plankton float in the water. One kind is phytoplankton, the plants. The other kind is zooplankton, the animals. When someone says just "plankton" it means both the phytoplankton and the zooplankton, or all the floating plants and animals.



PHYTOPLANKTON



ZOOPLANKTON

As we discuss plankton, we will for the most part be talking about microscopic plankton. You should be aware, however, that some planktonic jellyfish may be as large as three feet across. And one kind of planktonic plant, called gulfweed, grows in great patches that float near the surface of the water.

1. What does the word "microscopic" mean? ____________________

____

2. What are plankton? ____________________________________

____

____

3. What are the two different kinds of plankton?

a.) ____

b.) ____

Where It All Begins

Phytoplankton may be accurately called the "grass of the sea". They serve much the same purpose that grass and other green plants do on land.

Land plants trap and store energy contained in sunlight. Then when animals eat the green plants, they use the energy that the plants have stored. Because plants store energy and produce food for other creatures in this way, they are called producers.

In the ocean, the situation is very similar. Phytoplankton store energy contained in sunlight, and thus produce food for other creatures. So, they are the producers in the ocean community. Since phytoplankton need sunlight, they are found only near the surface of the ocean where the sunlight can reach them.

4. Why are plants called producers? ______________________________

____

5. What are the producers in the ocean community? ________________

____

Where It Goes

On land, many creatures eat the green plants. Cows, horses, many insects, and many other small animals feed on the food the producers have stored. Because these animals consume this stored food, they are called consumers. But what about other animals (such as man) that eat the consumers (such as cows)? Aren't they consumers also?

To put this a little more clearly, we can draw what is known as a food chain:

man (consumer)
↑
cow (consumer)
↑
green plants (producers)

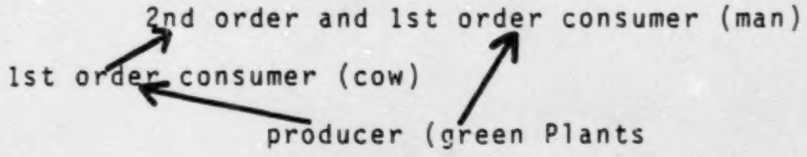
This is a very simple food chain. What it says is that the man ate the cow that ate the green plants. The arrows show which way the energy that the plants stored is moving.

6. Draw a simple food chain with at least three links (Hint: What did you have for dinner last night? What did it eat? Remember that the arrows show which way the energy that the plants stored is moving.)

But sometimes we need to be able to tell whether the consumer we are talking about was one who ate the producer, or one who ate another consumer. So, we call a consumer who eats green plants a 1st order consumer. Then, we call a consumer who eats a 1st order consumer a 2nd order consumer. Now, our food chain looks like this:

2nd order consumer (man)
↑
1st order consumer (cow)
↑
producers (green plants)

7. Label the links in the food chain you drew in question six.
Which animal is a first order consumer?
Wait a minute! People sometimes eat green plants! OK, when they do, they are 1st order consumers. Draw the food chain this way:



Now our food chain is a food web. A food web is made up of several food chains. There are many such food chains and food webs both on land and in the sea. Sometimes they become very complicated.

8. Use the organisms listed below to construct a food web:

man

coyote

cow

deer

grass

9. On the food web you have just drawn, label the producers, the first order consumers and the second order consumers.

10. Is any animal both a first and second order consumer in your food web?

If yes, Which one?

We have already said that phytoplankton are the producers in the ocean. What are the 1st order consumers?

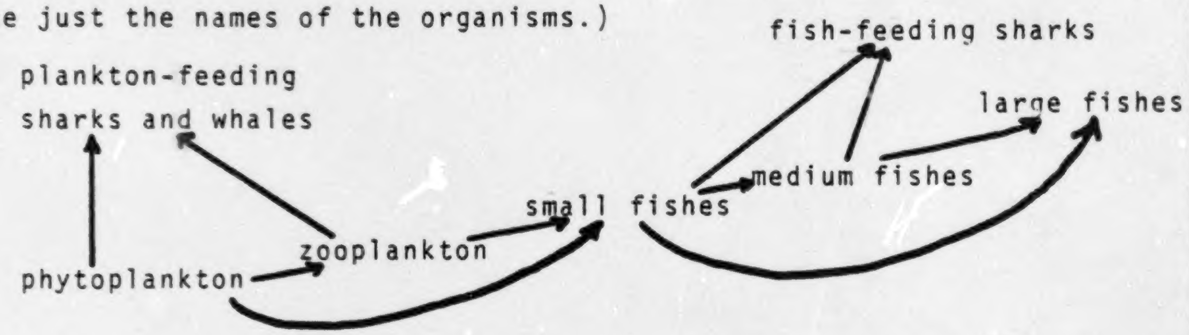
Well, zooplankton are. So, we can begin an ocean food chain this way:

1st order consumers (zooplankton)

↑

producers (phytoplankton)

Some whales feed on only plankton, both phytoplankton and zooplankton. So lets add whales and some fishes and we can draw a food web that begins to get complicated. (To make it easier to read, we will write just the names of the organisms.)


fish-feeding sharks
plankton-feeding sharks and whales
large fishes
medium fishes
small fishes
zooplankton
phytoplankton

If we wanted to, we could keep adding to this, until it became much more complicated.

Use the ocean food web to answer the following questions:

11. What two things are the small fishes eating?

a.) ____

b.) ____

12. Which animals in the web are both first and second order consumers?

____

____

13. The fish feeding sharks can be third order consumers, fourth order consumers or fifth order consumers according to this food web.

Beginning with the phytoplankton, list the links in the food chain that would make the fish feeding sharks fifth order consumers.

Now let's isolate one food chain out of this food web and see how much plankton it takes to feed, for instance a large fish.

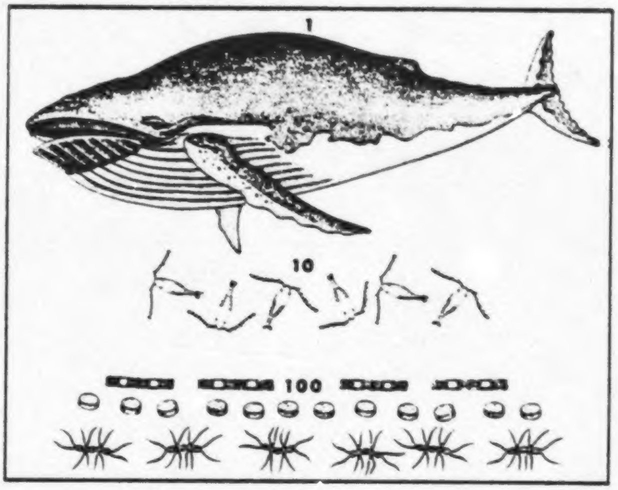
4th order consumer - large fish 1 pound
↑
(an example of a large fish is a tuna)
|
3rd order consumer - medium fish 10 pounds
↑
2nd order consumer - small fish 100 pounds
↑
1st order consumer - zooplankton 1,000 pounds
↑
producer - phytoplankton 10,000 pounds

As a general rule, it takes 10 pounds of producer for the 1st order consumer to gain one pound. It takes 10 pounds of 1st order consumer for the 2nd order consumer to gain one pound, and so on.

The drawing shows the amount, by weight, of plankton and small and medium fish that a large fish (tuna) must eat to gain one pound. Though the tuna does not eat plankton, it eats medium fish, that eat small fish, that eat zooplankton, that eat phytoplankton. Thus, the tuna is ultimately dependent on the phytoplankton.

You can see that it takes 10,000 pounds (that's 5 tons!) of phytoplankton for a tuna to gain one pound. Without phytoplankton, we would have no fish to eat. Not only must plankton be present, they must be present in enormous numbers. Plankton are the basis for all fish life in the ocean.

The diagram shows a typical ocean food chain. Approximately 100 tons of phytoplankton are required to produce a one ton whale.



14. What level consumer is the whale shown? ____________________

____

15. If the whale was a fourth order consumer, instead of what it is how many pounds of phytoplankton would it indirectly eat to gain its one ton weight? (Hint: from the drawing above we can tell how many pounds of producer it takes to produce one pound of fourth order consumer. One ton is 2000 pounds). Please show your work.

16. Why do we say that plankton is the basis of all fish life in the ocean?

____

____

____

TEACHER BACKGROUND - Cross Web

This crossword puzzle serves as a vocabulary review to strengthen the students' familiarity with the material covered in "The Biological Environment" reading section.

Duplicate the puzzle. One puzzle per student.

This puzzle provides an opportunity for individual or small group work. You may elect to allow time for individual work followed by a time for small group work. Since this activity is for reinforcement, everyone should be encouraged to finish and should be provided with the help necessary for completion.

KEY

See attached puzzle.

KEY WORDS

The key words are the definitions used in the puzzle.

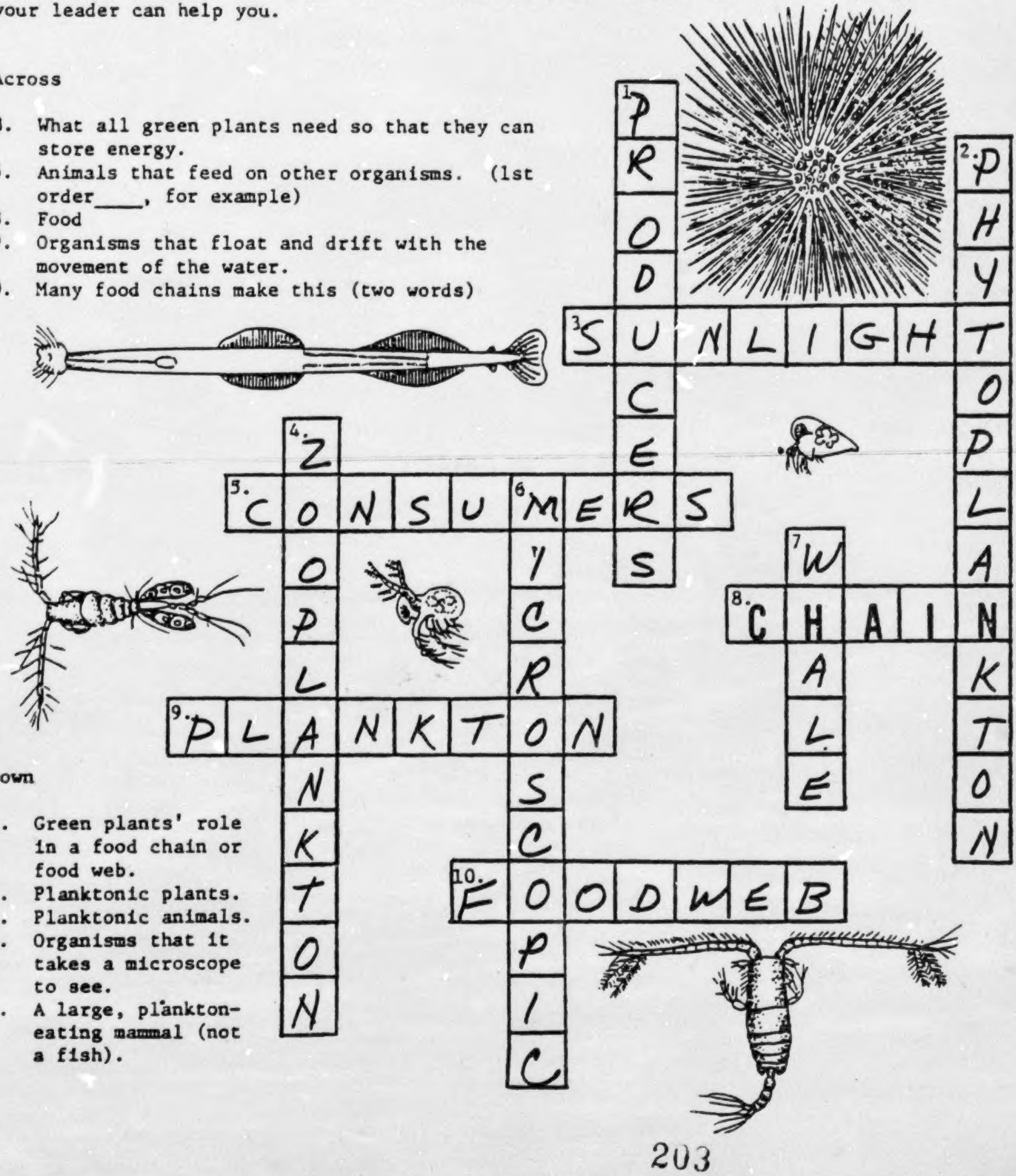
The crossword puzzle originally appeared in the Florida 4-H Marine Program pamphlet "plankton - The Basis of Life" by Mrs. Carolee Parmer.

A Crossword Puzzle

Here is a crossword puzzle. Many of you have probably seen or worked one of these; in case you haven't, here's how you do it: You are given a set of clues. Each clue describes a word you learned in this project. Figure out what each word is and write it in the row of boxes that begins with the same number that the clue is. An example is given for you: Clue number 8 across is "Food______". You want a word that will go in the blank, and has as many letters as there are boxes (5). The word is "chain". It has been filled in for you. If you have trouble going on, your leader can help you.

Across

3. What all green plants need so that they can store energy.
5. Animals that feed on other organisms. (1st order____, for example)
8. Food
9. Organisms that float and drift with the movement of the water.
10. Many food chains make this (two words)


1. PRODUCERS
2. PHYTOPLANKTON
3. SUNLIGHT
4. ZOOPLANKTON
5. CONSUMERS
6. MICROSCOPIC
7. WHALE
8. CHAIN
9. PLANKTON
10. FOODWEB

Down

1. Green plants' role in a food chain or food web.
2. Planktonic plants.
4. Planktonic animals.
6. Organisms that it takes a microscope to see.
7. A large, plankton-eating mammal (not a fish).

CROSS WEB

Here is a crossword puzzle. Many of you have probably seen or worked one of these; in case you haven't, here's how you do it: You are given a set of clues. Each clue describes a word you learned in this project. Figure out what each word is and write it in the row of boxes that begins with the same number that the clue is. An example is given for you: Clue number 8 across is "Food______". You want a word that will go in the blank, and has as many letters as there are boxes (5). The word is "chain". It has been filled in for you. If you have trouble going on, your leader can help you.

Across

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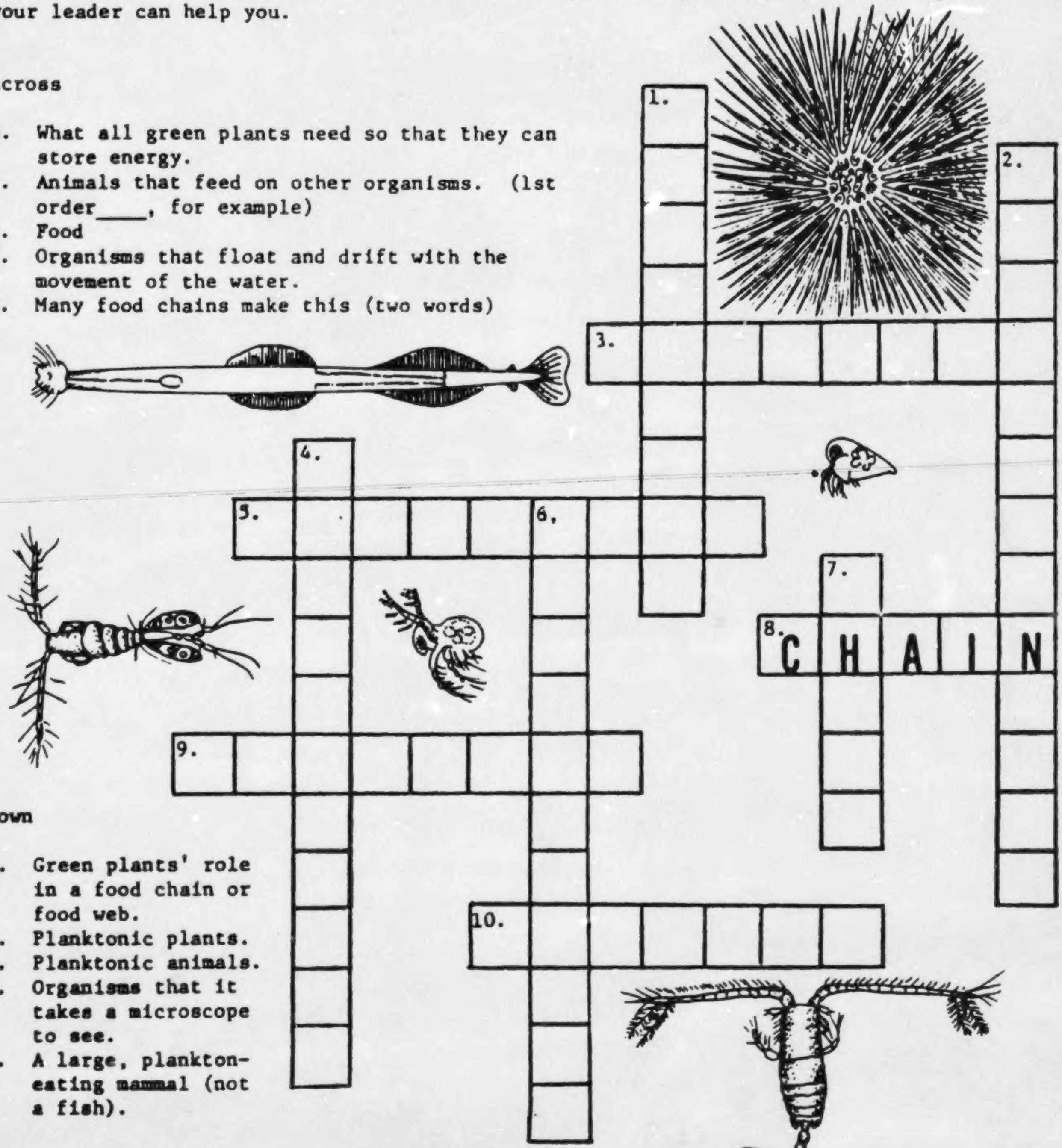


Down

1. Green plants' role in a food chain or food web.
2. Planktonic plants.
4. Planktonic animals.
6. Organisms that it takes a microscope to see.
7. A large, plankton-eating mammal (not a fish).

TEACHER BACKGROUND - Plankton and the Food Chain

This activity is designed to help show the importance of plant life in the marine ecosystem. It also reinforces the material on food chains. The role of nutrients and fertilizers in aquatic plant growth is also investigated.

The aquarium tanks used should be all glass if sea water is used. Plastic containers may be substituted if they are transparent or opaque. One set-up per class is all that is required. Let students help in the labeling of the tanks etc. You may elect to have different groups add the fertilizer or detergent at the experimental tank each day.

Duplicate the activity and provide one set per student.

Provide paper for recording daily changes and water temperature.

Have students keep a running record of the changes.

KEY - results and intrepretation

1. Depends upon results. The tank will probably turn light green.
2. Depends upon results. The tank will most likely become very green and turbid. More color than the control tank.
3. The greener tank had the greatest numbers of phytoplankton.
4. The greener tank would have the highest oxygen following the reasoning given. Probably the experimental tank in this case.
5. If the oxygen level is reduced the fish might die.
6. Waste water high in phosphates from detergents may cause plankton blooms which can cause a reduction in oxygen level as they die. The reduced oxygen level could cause local fish kills. This is usually a problem in lakes and rivers and occasionally in isolated ocean bays. The open ocean would be less affected.

KEY WORDS

artificial

atmosphere

bloom

byproducts

carbon dioxide

control

decay

experimental

fertilizer

food chain

food pyramid

graduated cylinder

microscopic

oxygen

phosphate detergent

photosynthesis

phytoplankton

plankton

primary producers

simple sugars

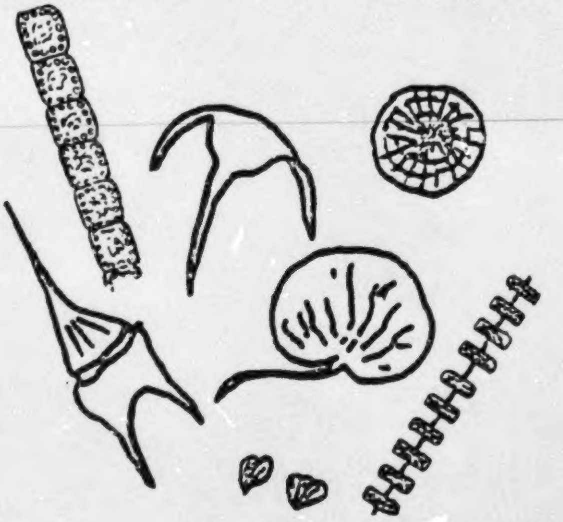
zooplankton

turbidity

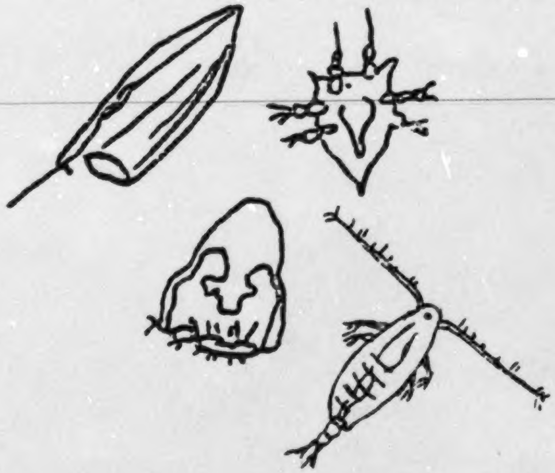
This activity is adapted from "Plankton and the Food Chain (Plankton 1)" which is part of the Oregon State University Sea Grant Marine Advisory Program Marine Science Education Tips series.

PLANKTON AND THE FOOD CHAIN

Plants in the sea include both the large sea weeds that we are all familiar with and tiny microscopic drifting plants called phytoplankton. The tiny plants we cannot see with the unaided eye support either directly or indirectly most of the life on this planet. These plants, like the green plants of the land, can combine carbon dioxide with water, using energy from the sun, and produce simple sugars in a process called photosynthesis. This food is the basis on which all other life depends. One of the by-products of photosynthesis is oxygen, which all animals need in order to survive. Over 70% of the atmosphere's oxygen is produced by phytoplankton.



PHYTOPLANKTON



ZOOPLANKTON

Planktonic food producers are called primary producers and are the first step in the food chain in the sea. They are eaten by the tiny marine animals called zooplankton, which in turn are eaten by small fish and other animals, which in turn are eaten by larger fish, etc. Thus there may be first-, second-, third-,and sometimes fourth-level consumers in a food chain.

Materials:

Two ten gallon aquarium tanks per class
20 gallons of sea water or fresh water from a lake or pond
phosphate detergent of fertilizer
10 ml graduated cylinder or 1/4 teaspoon measure
thermometer

Method:

1. Place the tanks in a location where they will receive sunlight. (If no sunlight is available, artificial light may be used, gro-lux plant lights work best).
2. Label one of the tanks as "CONTROL". Label the second tank as "EXPERIMENTAL".
3. Fill each tank to the same level (about one or two inches from the top) with sea water or freshwater from a pond or lake.
4. Each day, add 1½ millilliters of household phosphate detergent or fertilizer to the experimental tank. (5 ml - 1 teaspoon)
5. Record daily water temperature, turbidity (how cloudy the water is becoming), and general appearance.
6. Continue the experiment until the water becomes turbid and green with a plankton bloom.
7. Keep the water for further studies.

RESULTS AND INTERPRETATION

1. Describe what happened to the water in the control tank. __________

    ____

2. Describe what happened to the water in the experimental tank. How did this differ from what happened in the control tank? __________

    ____

    ____

3. If the turbidity (cloudiness) in the tanks is due to phytoplankton, which tank had the greatest numbers of phytoplankton? ____________

____

4. Phytoplankton produce oxygen. Which tank do you think would have the higher level of dissolved oxygen? Why?

____

____

Fertilizer and phosphate detergents can increase the growth of phytoplankton. If they reach large numbers, many phytoplankton below the surface layer can not get enough sunlight and they die. When they die they begin to decay. Decay removes oxygen from the water. Large phytoplankton blooms can therefore cause a reduction in the oxygen in the water.

5. What might happen to fish if the oxygen level is reduced?

____

____

____

6. Why might waste water that contains detergents be harmful to the balance of life in the ocean or in a lake? ____________

____

____

____

TEACHER BACKGROUND - Plankton Investigation Lab

This activity is designed to permit students to observe living plankton. The Plankton Investigation Lab can pose some logistics problems. If you are fortunate to have a stereo microscope in your school, you should have little trouble with this lab. If you do not have a stereo microscope, you should consider borrowing one from the junior or senior high school. If this activity is done with only one or two stereo microscopes, plan to do this activity simultaneously with the last day of "Plankton and the Food Chain".

Duplicate the activity pages. One set per student. Provide orientation for the class in the use and proper care of the stereo-microscope. Provide information about the general plankton forms. See the introduction to the pictoral key, A Guide to Marine Coastal Plankton by DeBoyd L. Smith. Published by West Coast Plankton Studies, Campbell, California in 1971 (82 pages). Explain the use of the pictoral key.

You may elect to have students make their own plankton nets following the directions on the next page. If so, the students should collect their own plankton sample. If the ocean, a pond, or a lake is not convenient, you may obtain a plankton sample from the tanks set up in "Plankton and the Food Chain."

PLANKTON

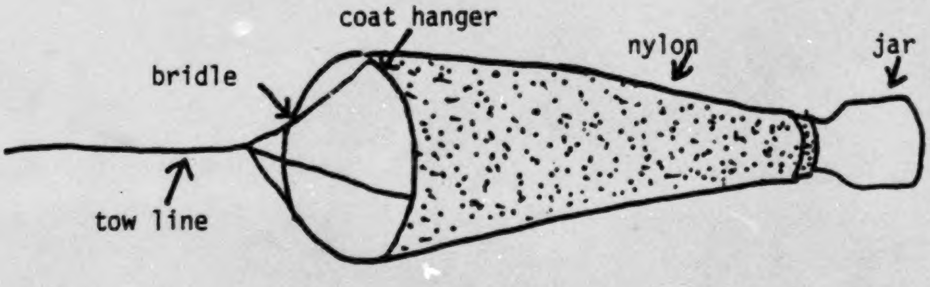
PLANKTON NET PROCEDURE SHEET

MATERIALS:

nylon stocking
metal coat hanger
wire cutters
needle and strong thread
scissors
small bottle (baby food jar)
string or twine
pliers

PROCEDURE:

1. Use pliers to unwind coat hanger and straighten.
2. Encircle top of stocking, bend wire to fasten and cut off extra length.
3. Fold top of stocking down over wire on the inside of the sotcking and sew around rim so that wire is firmly fastened all the way around and is covered by the stocking top.
4. Cut the stocking back from the toe or near the heel and tie the cut end on the bottle neck.
5. Twine or heavy string should be used to make a tow line (10 to 20 feet) and bridle.



KEY - results and interpretation

Drawings should reflect what is seen.

1. The answer depends upon the results. If the water sample is from the tanks from "Plankton and the food Chain", there will probably be more phytoplankton than zooplankton.
2. Answer depends upon the results.
3. Answer depends upon the results.
4. Depends upon the microscope used. Multiply the power of the eye-piece (stamped on the eyepiece lens case) by the power of the lower, or objective lens (engraved on the lens case).
5. We might estimate the number of plankton in a gallon by using a sampling procedure. Count the number in a known size drop and multiply the number of plankton times the number of drops in a gallon.

   For the ocean, (just) estimate the number of gallons in the ocean and multiply times your number of plankton per gallon. These manipulations assume uniform distribution of plankton in the larger samples. They also assume that the drop is representative of the larger body of water from which it came.

   Even if we knew the number of gallons in the oceans, these answers would not be very realistic because they ignore the fact that the plankton net concentrates the plankton. For a more accurate answer one would also need to know the size of the net, the distance the net was towed, at what water level, at what season, at what time of day, at what location, etc. The important thing to emphasize is that a sampling procedure can be used to estimate large quantities.

KEY WORDS

abundant

larvae

magnification

microscope

petridish

phytoplankton

plankton

sample

scan

stereo microscope

temporary zooplankton

permanent zooplankton

zooplankton

PLANKTON INVESTIGATION

Plankton are forms of drifting plant or animal life in the sea regardless of size.

The two major divisions of plankton are PHYTOPLANKTON and ZOOPLANKTON. Phytoplankton are the plant forms of plankton and Zooplankton are the animal forms of plankton.

The Zooplankton may be either temporary plankton or permanent plankton. Temporary Zooplankton spend only part of their life span as plankton. Permanent Zooplankton spend their entire life in the plankton world. Temporary Zooplankton are larve of marine animals or fishes. Larve means the first state of life after the egg. In some respects the larval stage may correspond to the "baby" stage in other animals.

In this investigation you will have a chance to observe living plankton.

Materials

plankton sample
eye dropper
stereo microscope
petri dish
guide to identification of plankton

Method

1. Obtain plankton sample. (Plankton may come from the tanks set up in "Plankton and the Food chain", or may be collected with a net).
2. Use an eyedropper to place several drops of the plankton sample in a petri dish.
3. Scan the field and observe the plankton. Identify the plankton seen by using the picture guide.
4. Draw what you see in the microscope even if it doesn't look just like the drawing in the picture guide.
5. Label what you have drawn - Zooplankton or Phytoplankton

(1) Zooplankton	(2) Zooplankton
(3) Zooplankton	(4) Zooplankton
(1) Phytoplankton	(2) Phytoplankton
(3) Phytoplankton	(4) Phytoplankton

RESULTS AND INTERPRETATION

1. In your sample, are zooplankton more numerous than phytoplankton?

   ____

2. Which organism was most abundant?

   ____

3. Which organisms did you see that are permanent zooplankton?

   ____

   ____

4. What was the magnification you used to observe the plankton?

   ____

5. How might we estimate the number of plankton in a gallon of water? In the ocean?

   ____

   ____

   ____

   ____

   ____

TEACHER BACKGROUND - Marine Life

This activity is designed to improve reference skills and writing skills. It also will provide an opportunity for the students to see the variety of creatures that live in the sea.

Duplicate the pages of the writing activity. One set per student.

Provide paper and as many reference books and magazines as you can find. This is a good time to renew your acquaintance with the school librarian and the public librarian, as well. Overwhelm your students with choices. Decide whether you will permit in-class use only or whether you will permit books to go home. This is a hard decision that will depend upon your particular situation.

A trip to the school library with your class can be most worthwhile, especially if you give the librarian a little warning.

Encourage the students to use the format given. Be sure to explain the things necessary for a complete literature citation.

Students should use complete sentences in providing the information required.

A time for sharing of favorite animals can be profitable.

Post the reports on a classroom bulletin board.

KEY WORDS

appendages

gills

predators

reference

segments

tentacles

tube feet

MARINE LIFE

The ocean is full of the most incredible animals. Animals range in size from smaller than the head of a pin to longer than a basketball court. This is your chance to learn about some of these creatures.

Use the books your teacher provides, as well as books in the library, to prepare brief information sheets about marine animals. For each animal:

A. Include animal name and such characteristics as size, color, number of appendages, where most commonly found, what it eats, predators, interesting features, etc.

B. Include picture or drawing of each animal.

C. List the references you used in your report. Give the author, date published, title, publisher and number of pages for a book. For example,

Ward, Ritchie. 1974 Into the Ocean World, Alfred A. Knopf, Inc. New York. 323 pages.

Use the following format for magazines:

Holt, S.J. 1969 "The Food Resources of the Ocean" in Scientific American volume CCXXI, September 1969.

All of the information required can be found on the first few pages of a book and by looking carefully at the small print near the beginning of a magazine. Get in the habit of giving this information so that others may look at the original article too!

D. Select animal having any of the characteristics listed below:

1. single shell
2. two shells
3. one foot
4. tube feet
5. many spines
6. shaped like the spokes on a wheel
7. eight arms
8. paired, jointed legs
9. ten appendages
10. many tentacles around the mouth
11. tube feet and branched tentacles around the mouth
12. gills and fins
13. tube dwelling
14. many small individual animals living together (colonies)
15. many segments
16. uses foot for feeding
17. jointed legs -- lives in someone else's shell
18. eight plates
19. two shells -- can swim by flapping shells
20. neck may be longer than three feet
21. snail without shell
22. ten arms--looks much like octopus
23. fins --two eyes on side of head
24. twenty-one arms
25. fins and sucker
26. jelly-like blob
27. sea slug -- no shell
28. A characteristic not listed above.

E. Prepare as many written reports as you are able to do. You may make reports on more than one animal for each characteristic listed. Others will want to read your reports if you make them interesting.

TEACHER BACKGROUND - The Marine Aquarium

This exercise consists of three activities. All of the activities center on the marine aquarium in your classroom. If you do not have a marine aquarium, the activities can be modified for use with a freshwater system or omitted.

Duplicate the three pages of activities. One set per student. Provide additional Animal Identification pages as needed.

Activity one is a simple listing of the animals present in the aquarium. Provide reference materials that describe the animals your aquarium contains. Let the students discover the identities with your aid.

Activity two gives the student a chance for a more in depth look at some of the animals in the tank. Again provide the reference materials for the students to complete the forms.

Activity three is a simple log of water temperature along with additional observations. You can either take the readings yourself and post them on the board or you can have groups of students take and post the readings.

The temperature should be recorded at the same time each day. If you have your students record the temperature at several times during the day you may notice differences. These observed changes can be a springboard for a discussion designed to find correlations between the temperature changes and classroom activities. For example, the temperature may go down each day at recess time because the classroom door is left open, etc.

These activities can be done individually.

KEY

All answers depend upon the contents of your aquarium.

KEY WORDS

aquarium

appendages

identification

marine aquarium

observation

ph

predator

THE MARINE AQUARIUM

The marine aquarium in your class contains salt water and salt water animals. Marine animals are very interesting to watch. We can also learn about the marine environment from the animals in the aquarium. Use the marine aquarium to do the next activities. List the animals you can see in your aquarium.

Fill out an animal identification form for as many animals as you can.

Make and record daily observations on the marine aquarium.

THE MARINE AQUARIUM - ANIMAL INVENTORY LIST

NO. ANIMAL NAME

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________
11. ______________________________
12. ______________________________
13. ______________________________
14. ______________________________
15. ______________________________
16. ______________________________
17. ______________________________
18. ______________________________
19. ______________________________
20. ______________________________

NO. ANIMAL NAME

21. ______________________________
22. ______________________________
23. ______________________________
24. ______________________________
25. ______________________________
26. ______________________________
27. ______________________________
28. ______________________________
29. ______________________________
30. ______________________________
31. ______________________________
32. ______________________________
33. ______________________________
34. ______________________________
35. ______________________________
36. ______________________________
37. ______________________________
38. ______________________________
39. ______________________________
40. ______________________________

THE MARINE AQUARIUM - ANIMAL IDENTIFICATION

1. Name of animal:

2. Color of animal:

3. Describe shape of animal:

4. Describe how animal moves:

   If the animal is not moving, describe how it could possibly move.

   Why is there a need for this animal to be able to move:

5. Number and description of appendages (arms or legs):

6. Approximate size of this animal in centimeters:

7. What do you think this animal eats:

8. Describe how you think this animal eats:

9. Name of predator (enemy):

10. How does this animal protect itself:

11. What interesting characteristics or habits does this animal have:

Draw your animal

THE MARINE AQUARIUM - OBSERVATIONS AND MEASUREMENTS

	Mon.	Tues.	Wed.	Thurs.	Fri.
Water temperature					

	Mon.	Tues.	Wed.	Thurs.	Fri.

List anything added or taken from the aquarium:

Observations:

TEACHER BACKGROUND - Marine Life Crossword

The Marine Life Crossword is designed to serve as a review for the student research papers on Marine Life and for the activities focusing on the aquarium. Since not every aquarium will have the same inhabitants, the words that answer the clues are given in the Word List.

Duplicate puzzle pages. One set per student.

This activity may be done individually or in small groups. Alternatively, it can be done individually then in small groups. Use the approach that works best with your class.

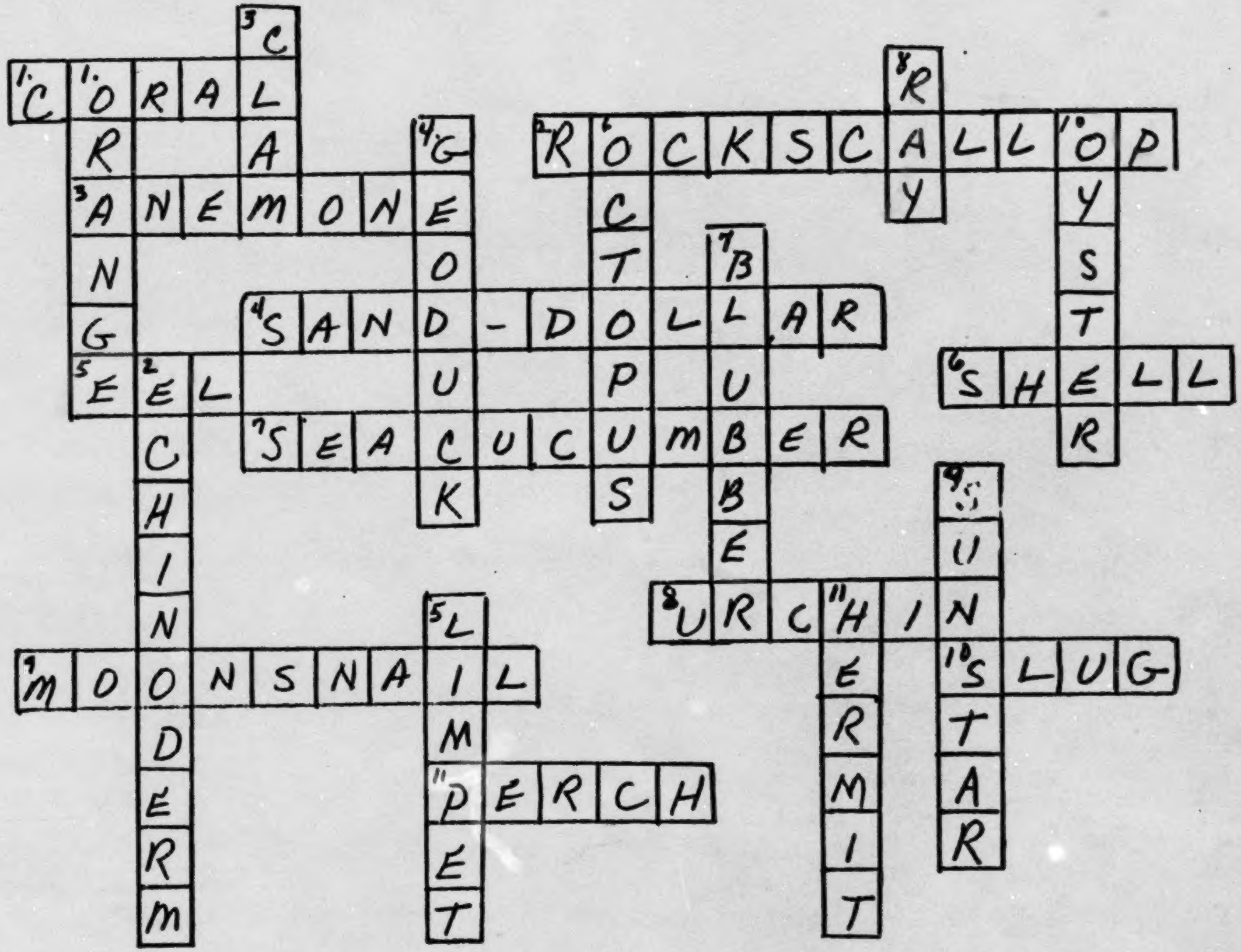
KEY - answers

The answers are on the completed teacher key.

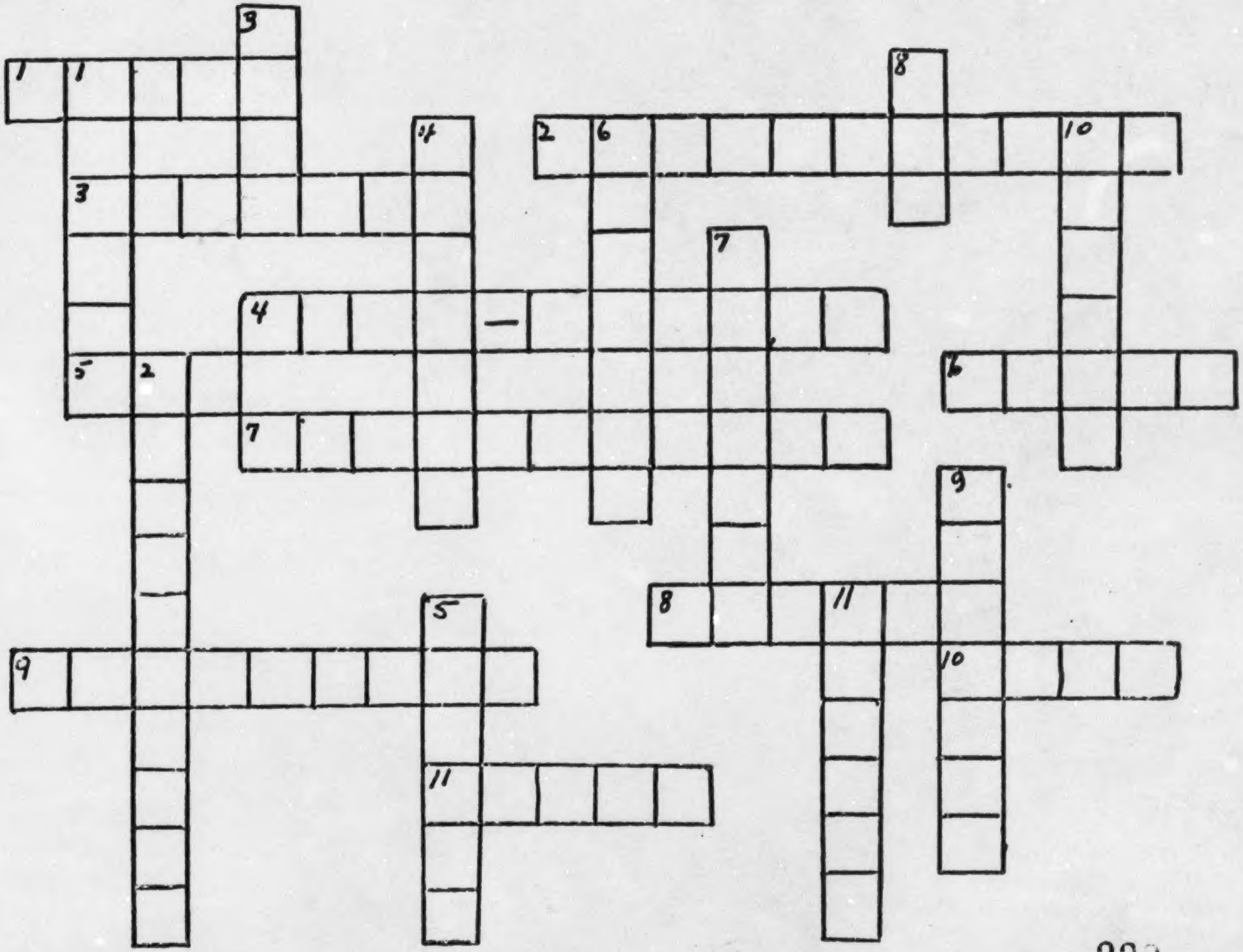
KEY WORDS

The key words are the clue solutions.

KEY - Marine Life Crossword


1 CORAL
1 ORANGE
3 CLAM
3 ANEMONE
4 GEODUCK
4 SAND-DOLLAR
5 EEL
2 ECHINODERM
7 SEACUCUMBER
2 ROCKSCALLOP
6 OCTOPUS
7 BLUBBER
8 RAY
10 OYSTER
6 SHELL
9 SUNSTAR
8 URCHIN
11 HERMIT
10 SLUG
9 MOONSNAIL
5 LIMPET
11 PERCH

Marine Life Crossword


3
1
1
8
4
2
6
10
3
7
4
5
2
6
7
9
5
8
11
9
10
11

CROSSWORD PUZZLE

ACROSS

1. Many animals forming a reef
2. Orange lips, many eyes
3. Tentacles around the mouth
4. Round, flat, and with tube feet
5. A long "slippery" fish
6. A protective covering
7. Not a vegetable
8. Many spines
9. Has one huge slippery foot
10. Related to snails
11. Common Puget Sound fish

DOWN

1. A bright color
2. The group with tube feet
3. Bivalve (two shells)
4. Not a bird
5. A hat shaped shell
6. Powerful beak
7. Whales have a lot of it
8. An arm
9. Lots of rays
10. May have pearls
11. Borrows a shell

WORD LIST

1. coral
2. algae
3. blennies
4. clam
5. oyster
6. kelp
7. moonsnail
8. limpet
9. chitons
10. octopus
11. shrimp
12. ray
13. slug
14. shell
15. seals
16. sunstar
17. urchin
18. jellyfish
19. rockscallop
20. leather star
21. eel
22. orange
23. plume
24. anemone
25. sand dollar
26. purple
27. sea lions
28. seacucumber
29. echinoderm
30. geoduck
31. blubber
32. barnacles
33. bivalves
34. hermit
35. perch

UNDERSTANDING ENVIRONMENT

TEACHER BACKGROUND - Understanding Environment

The activities preceding "Understanding Environment" have given the student a chance to study some of the relationships that exist between organisms and the non-living environment and also the relationships between the organisms themselves. This activity is designed to show the student some current environmental concerns and show them how the terms environment, ecology, etc. are used in the media. This section deals primarily with man's relationship to his environment.

The activity involves reading two articles from popular magazines. Reading guides are included to assist the students in recognizing the main ideas and to reduce the difficulty of the readings. Offer whatever assistance is required so that you students may be able to read and understand the articles.

Duplicate the articles and the reading guides. One set is required per student.

While the students should read the articles independently, you may find it beneficial for them to form small groups to complete the reading guides.

As the students read the articles, have them underline as many of the key words as they can find. You may add to the list of key words as you see fit.

Plan to devote a few minutes to discussion of the reading guides. Since this is a rather long activity, it is suggested that the articles be read on consecutive days.

After reading and discussing the two articles, have the students break into groups of six and ask each group to write a definition of each word on their sheet. The definitions should come from the information in the two articles.

Students should list their sources. More than one group should define the same words so that a comparison can be made. This should point out that definitions vary according to usage and source of information. The understanding that words mean different things to different people or groups is also gained.

As a summary for the section, test understanding of the key words through administration of the "multiple choice inventory" which is included.

KEY - reading guides

The keys are included on the next pages.

KEY WORDS

Environment
Man
Populations
resources
Economic
Social
Culture
Individual
Life
Needs
Values
Long-range
Political
Public
Quality
Society

This activity is adapted from "Understanding Environment" by Project Coast, University of Delaware.

Optional:

Have each student write a one-page paper on the current problem or problems of our society that are affecting the student and his family; for example, the energy crisis, the gasoline shortage, or whatever may be currently in the newscasts or newspapers. Ask the student to use at least half of the key words in his paper and to underline them. The papers may be exchanged at random and read before the group. Take time to discuss what has been read and relate present problems to the predictions and concerns found in the four articles.

KEY WORD MULTIPLE CHOICE INVENTORY

Environment

A. Ecology.
B. The shallow layer of loose surface soil.
* C. The sum total of all the external conditions which may influence organisms.
D. Any part or condition that influences the life of one or more organisms.

Man

A. An animal that attacks other animals.
B. Ecological relationships.
C. The group of animals that live on land.
* D. A human being; the human race; mankind.

Populations

* A. All the individuals of a group in a given area.
B. The control or influence of the behavior of a group.
C. The sum total of environmental conditions of a specific place.
D. A hole formed in rock by the grinding action of a stone kept in motion by a stream.

Resources

A. An area of land which is undisturbed by man.
B. Refers to the Rocky Mountains.
C. Fine material formed by the action of a glacier grinding rocks in its base as it moves forward.
* D. Something that lies ready for use or can be drawn upon for aid; supply of something to take care of a need.

Social

* A. Having to do with human beings living together as a group in a situation requiring that they have dealings with one another.

B. Anything that threatens the welfare of man.

C. Gathering of people for recreation.

D. What can be dissolved.

Culture

A. A mixture of was-like materials.

* B. The concepts, habits, skills, arts, instruments, and institutions of a people in a given period.

C. Religion.

D. Refinement.

Individual

A. The quality, state, or fact of being indifferent.

B. Lack of good judgement.

*C. Existing as a single, separate thing or being.

D. Anger resulting from persons being mean.

Life

A. The time during which an individual lasts.

B. Closely resembling a real person or thing.

C. Formerly a magazine published in the United States

*D. The property of plants and animals which makes it possible to take in food, get energy from it, grow, adapt to surroundings, and reproduce their kind.

Need

*A. Lack of things necessary or desirable.

B. Lie sheltered or partly hidden.

C. Security from wanting.

D. Craving, longing, desire, or wish.

Values

A. Being worth money.

B. Lightness or darkness of color

C. Exchange of currency of one country with another country or individual.

*D. Ideals, customs, institutions, etc.,of a group of people regarded in a particular, especially favorable, way by the people of the group; worth, merit, or importance.

Long-range

A. Designed to shout over a great distance.

B. Having continued for a long time.

*C. Taking the future into consideration.

D. Having or tending to have a long life span or existence.

Political

A. Having practical wisdom.

B. The right to participate in determining the form, choosing the officials, making the laws and carrying on the functions of one's government.

C. Organization and methods of government.

*D. Of, or concerned with, government, the State, or politics.

Public

*A. Of, belonging to, or concerning the people as a whole.

B. General opinion of the people.

C. Relations with people.

D. Works constructed by the government.

Quality

A. The exact amount of a particular thing.

*B. That which makes something what it is; basic nature; character; kind or degree of excellence possessed.

C. Pleasingly odd or curious.

D. That property of any thing which can be determined by measurement.

Society

* A. A social group of individuals, of one species, who cooperate in their activities.

B. Prominent and fashionable.

C. The study of people and how they live.

D. Any service or activity designed to promote the welfare of the community.

Economic

A. The study of the interrelationships of organisms.

B. Balance of nature.

* C. Pertaining to the production, distribution, and consumption of wealth.

D. The long, dry period of the year in tropical America.

KEY - answers

CRUD HO!

I. Read the following statements carefully. Check those statements that are actually stated or paraphrased in the article. Be ready to explain what is inaccurate about the statements that you do not check.

__✓__ 1. Some people are afraid that pollution has exceeded the capacity of nature to cleanse herself and that the Earth has had it.

__✓__ 2. People felt that the sewage, garbage and factory wastes that the rivers carried into the sea could not pollute the ocean because of its size.

____ 3. No one accepts litter, foul air and polluted water as a way of life.

__✓__ 4. The environmental "instrument panel" showed that there was trouble on the spaceship Earth.

__✓__ 5. The only threat to civilization is civilization.

II.

The following generalizations may or may not be true, based upon what the author implies. Check those that you feel can be supported by the story. Be ready to support your opinions.

____ 1. The quality of the environment has remained the same during Arthur Godfrey's life time.

__✓__ 2. Progress without planning can bring pollution, filth and death.

__✓__ 3. The idealism of youth is necessary to clean up the environment.

____ 4. The danger to life as we know it is not severe enough to require immediate action.

__✓__ 5. We must all work toward a clean environment if we are to survive

DEBUNKING MADISON AVENUE (TEXACO)

I. Read the following statements carefully. Check those statements that are actually stated or paraphased in the article. Be ready to explain what is inaccurate about the statements that you do not check.

✓ 1. The advertisement from Texaco oil states that Texaco tankers never discharge oily wastes at sea and that Texaco supports all practical proposals to stop any oil tankers from dumping oily waters at sea.

✓ 2. Oil is sometimes flushed into the ocean when ocean water is used as balllast.

____ 3. Almost all of the world's tankers now use a process called "load on top" to reduce oil effluent (waste).

____ 4. Detection of oil tanker polluters is an easy matter.

✓ 5. The amount of oil pollution is increasing in spite of improvements in tanker technology.

✓ 6. Texaco opposes more restrictive regulations on the amount of oil waste permitted.

II. The following generalizations may or may not be true, based upon what the author implies. Check those that you feel can be supported by the article. Be ready to support your opinions..

✓ 1. Oil companies are using the media (newspapers, television, etc) to improve their image as pollution fighters.

____ 2. Texaco oil has done everything it possibly can to prevent oily tanker wastes from entering the ocean.

✓ 3. At Texaco oil, what they say and what they do are very different.

✓ 4. The author feels that we do no know enough about the effect of oil on the ocean ecosystem to allow oil tankers to dump oily waster into the seas.

____ 5. We can believe everything we read in advertisements.

UNDERSTANDING ENVIRONMENT

We hear the words "ecology" and "Environment" used often today. Ecology deals with relationships: relationships between living things and each other, and relationships between living creatures and the non-living world. Environment means the things that surround and affect living things. The words used in discussions of ecology and environment are not always well defined. Environmental management requires an understanding of man and his total relationship to his environment or surroundings. This activity is designed to show you the meanings of words frequently used in the study of ecology.

Procedure:

1. Below is a list of key words. In the two magazine articles that you will read, underline as many of these key words as you can.

Key Words.

Environment
Man
Populations
Resources
Economic
Social
Culture
Individual
Life
Needs
Values
Long-range
Political
Public
Quality
Society

2. Preview the reading quide for "Crud Ho! and complete the guide after reading the article.

3. Preview the reading guide for "Debunking Madison Avenue (Texaco)". Complete the quide after reading the article.

4. Follow the instructions from your teacher for the next steps.

CRUD HO!

Arthur Godfrey

"Man is the only animal who blushes or has need to" is a *bon mot* attributed to Mark Twain. And he was right. We are blushing—or should be. Our faces should be scarlet with burning shame. Mine is fiery red all the time. Why? Because I am one of those guilty millions who have systematically wrought the ecological rape of this once beautiful planet. We have so badly fouled our environment that today many are fearful that pollution has exceeded the capacity of nature to cleanse herself and our little spaceship, Earth, has had it!

Like everyone else, I have contributed my share of crud in my time. Cigar and cigarette butts in the streets, on the floors of public buildings, out the car window; empty packages, boxes, cans, wrappings, bottles, newspapers, magazines. I have scattered ashes and smoke in the breeze, poisonous *persistent* pesticides on the farm, hydro-carbons from my cars and boats and airplanes, and house-heating oil burners in the air and water. Rags, old rubber tires—yes, once I even left a battered heap of junk automobile on a side street back in 1929.

I have pumped raw sewage overboard in salt water anchorages from my boat and, under cover of night, have even dumped trash over the side. Yes, until a few years ago, I was as big a slob with my "people droppings" as anyone, and I've often wondered why.

I don't recall being particularly dirty as a youngster. Maybe I was, but I joined the Navy at 16 and damned soon learned to be clean. The Navy! Come to think of it, we always threw everything overboard. We kept the ship spic and span all right—but what a wake we must have left: raw sewage, bilge-pumpings, trash, garbage. Of course! The good old Navy "made a man of me" and taught me to love the sea as much as to respect her awesome power in storms; but I also acquired a badly exaggerated estimate of her ability to absorb human pollution, if indeed I ever thought about it at all. Which is probably the way it was: I never thought about it at all. *Nobody* ever did until recently, and most people don't think much about it even now.

I remember when the first factory was built on the Saddle River in New Jersey not far from where I went to school in Hasbrouck Heights. We couldn't swim or fish in the river after that because it had become polluted by the factory wastes. We kids complained about it some, but our elders didn't give a damn. In fact, they were glad because it was one less temptation for us to play hookey from school. Besides, lots of people got jobs in that factory. Saddle River Township was growing! This was progress. Yes, it was just about that time that the myth was established: Prosperity means progress means people—the more people, the more progress, the more prosperity. Too late we have seen that it also means more pollution, more filth, more death.

Little by little, I remember, the same thing happened to the Passaic River and the Hackensack and Berry's Creek. Of course, the Hudson had long since been ruined, even before Robert Fulton's time.

That's the way it all happened, I think. Nobody ever noticed except the kids and the folks downstream—who themselves sooner or later sold out to "progress" and joined the *growing economy*. Adding their own effluent to the mess, they shrugged: "What the hell, it's going out to sea! That's what rivers are for—to take the sewage and the garbage and the factory wastes out to sea! You can't pollute the ocean—it's too big, too vast!"

I can even remember when our elders taught us that water purifies itself in a stream every few hundred feet. All we had to do was go downstream a mile or so below town and we could drink the very water the town had flushed through the toilets. Typhoid fever played a big role in keeping the population down in those days.

Later, I remember "swimming call" aboard ship. In the early 20's I had served on two Navy destroyers stationed in Turkish Waters. Often on balmy days, while riding at anchor in some harbor like Smyrna, or Adalia or Beirut in the Mediterranean, or Samsoun or Trebizond or even Varna in the Black Sea, we sailors would dive happily overboard while the Quartermaster kept an eye out for sharks. We had very little trouble with sharks in those waters, but there was raw sewage in abundance. I remember one crusty old Boatswain's Mate on the USS Lawrence who, too smart to join us, used to delight in singing out: "Crud, Ho!"

If that sounds too ridiculous, consider the urban apartment-dweller today who goes out for a walk around the block with her dog for a "breath of fresh air." Meekly, impassively, she steps over, around, in-between and often through the dog-do, oil smears, garbage and trash without complaint. They even make bad jokes about it just as we old sailors did as we looked for holes in the harbor gook to dive through. It would be funny if it weren't so tragic. But it is tragic!

It becomes increasingly obvious that most people have become so accustomed to litter, foul air, and polluted water that they accept it nowadays as a way of life. Most young people, for instance, have never known anything else!

Why do I take time to speak of garbage and feces and litter? Let me try to explain. Forty years ago, in 1929, I learned to fly. Since then I have accumulated some 14,000 hours in almost every kind of aircraft—single- and multi-engine land and sea-planes, helicopters, and even blimps. The old barnstorming days we all loved are long gone, but nowadays, endless pleasure is derived from precision-flying, sleek little Lear Jets on instruments. I feel safe and relaxed at 500 m.p.h. in thick weather because I've been trained to believe my instruments. I scan them constantly—looking for small changes and making small corrections. Airspeed, power settings, temperatures, aircraft attitudes—a flicker of change gets a flicker of action. A big change gets proportionately big action. Always when anything goes wrong, lights come on to indicate the trouble source.

Mainly, I think, it's this training that led me to look at the indicators of this planet that I love and upon which I once felt safe and secure.

As a youth, the instrument panel read normal. I loved to walk through the woods and fields and swamps, and early became steeped in woodlore. As a young flyer, I drank in the clean vistas, the commanding view of America from spacious skies. As the years passed, I began to observe I wasn't flying from town to town anymore but from smoky spot to smoky spot on the horizon. (Smog hadn't been invented then.) Gradually, during the last decade, smog has become a reality and an almost unbroken carpet over land and sea.

I have also been an ardent canoeist, and later a yachtsman, most of my life. I remember how I used to enjoy taking a small boat up one of the inland waterways looking for quiet coves and marshes. After a time, the coves were jammed with other boats everywhere and the marshes were filled in by developers.

I have always had a love for hunting, too, in the North woods, in the Rockies and in Africa and India. I loved the solitudes of the wilderness and the lure of fine specimens. But the environments became restricted and the game too precious to shoot.

In a thousand ways the environmental instrument panel began to give me information: in the color of the atmosphere even far out over the Atlantic, in the harsh jam of a crowded street, in an oil slick—however tiny, in the surf at Waikiki. But no lights came on to identify the sources for me. I was confused and depressed because I felt so helpless.

Then I came across a marvelous book called *Moment in the Sun* by Robert and Leona Rienow who had worked together for thirty years documenting their theories.

When I had finished the book, my environmental instrument panel lighted up like a Christmas tree. I knew, now, what was wrong, what was causing the trouble signs, and I began to re-act. First, I tried to control my own life and get my own wings level, and then I began suggesting controls and guidelines to audiences everywhere. There is more information available now, though, more and more every day—more and more lights are coming on all the time. Frankly, I'm scared because the attitude gyros have tumbled and we're on our environmental backs. Now it's time for action and fast recovery or, my friends, we're going in!

What action do we take? We must look at man and his environment and find a view toward survival.

I have been very much impressed by what the younger people have to say. To be honest, I haven't sympathized very much with agitation or rebellion, but let me quote from a paper by Pennfield Jensen, a graduate student at San Francisco State College. "The naivete, enthusiasm and idealism of young people are not to be scorned, for they are the raw material of constructive growth. We will stop the destruction of this planet even at the cost of our futures, careers and blood. The situation is simply like that. If you are not going to live for the Earth, what are you going to live for?" That's good stuff. That's what it's going to take.

Is there time for us to wait for our youth to become effective? Is there time for agitation or civil war? I don't think so. Dr. DuBridge, Science Adviser to the President, has rightly said that population control should be the "prime task" of every government. He also said that as we proceed with this task, we must attend to our environment. But is there anyone—*anyone*—who thinks that this administration or the next or the next will act with the kind of force that's necessary?

What about action? What about a Department of Environmental Affairs? What about a "population pentagon?"

It's time now to recognize that the only threat to civilization is civilization. It's time to use what little time is left!

It's time to use all of our brains, all of our courage, all of our resources to act—to recover!

It's time to survive—to volunteer for survival!

Good luck! Crud Ho!

Reprinted from Man on Earth with permission.

Adapted from materials prepared by Project Coast.

CRUD HO!

I. Read the following statements carefully. Check those statements that are actually stated or paraphrased in the article. Be ready to explain what is inaccurate about the statements that you do not check.

____1. Some people are afraid that pollution has exceeded the capacity of nature to cleanse herself and that the Earth has had it.

____2. People felt that the sewage, garbage and factory wastes that the rivers carried into the sea could not pollute the ocean because of its size.

____3. No one accepts litter, foul air and polluted water as a way of life.

____4. The environmental "instrument panel" showed that there was trouble on the spaceship Earth.

____5. The only threat to civilization is civilization.

II.

The following generalizations may or may not be true, based upon what the author implies. Check those that you feel can be supported by the story. Be ready to support your opinions.

____1. The quality of the environment has remained the same during Arthur Godfrey's life time.

____2. Progress without planning can bring pollution, filth and death.

____3. The idealism of youth is necessary to clean up the environment.

____4. The danger to life as we know it is not severe enough to require immediate action.

____5. We must all work toward a clean environment if we are to survive

An advertisement from the New York Times

DEBUNKING MADISON AVENUE (TEXACO)

TEXACO PROHIBITS THE DISCHARGE OF OIL INTO THE SEA- ANYWHERE IN THE WORLD

International Conventions prohibit the discharge from tankers of oil or oily wastes within 100 miles of any shore.

Some years ago, Texaco voluntarily stopped its owned and chartered tankers from discharging oil or oily wastes into the sea anywhere in the world.

There are no exceptions to this rule.

The only discharge at sea by Texaco tankers is clean salt-water ballast. We hold on board all oily water and residue until pumped into tanks onshore.

Our "clean-seas" policy not only prevents pollution at sea, but permits us to reclaim valuable petroleum.

International proposals for NATO nations would prohibit all tankers from dumping oily ballast waters or tank washings at sea. Texaco endorses this requirement. Included in these proposals are restrictions which would prevent even clean salt-water ballast from being discharged at sea. On this point, Texaco offers a word of advice. Such a drastic proposal is both impractical and unnecessary. In our opinion, it does nothing to improve ocean environment, yet would result in added costs to the consumer.

Texaco supports all practical proposals to stop any oil tanker from dumping oily ballast waters or flushing tanks at sea. This follows our commitment that we will never willfully pollute the oceans of the world.

We know the problems.
We are trying to provide solutions.

TEXACO

Working to keep your trust.

Excerpted from Environmental Action with permission.

Adapted from materials prepared by Project Coast.

DEBUNKING MADISON AVENUE (TEXACO)

Like other major oil companies in the U.S., Texaco has flooded the media with pronouncements about its pollution control measures. This advertisement, which appeared in the November 9 *New York Times*, misrepresents Texaco as a firm doing everything in its power to keep from contaminating the seas. In fact, Texaco has an imperfect pollution control record; the measures it takes to "prohibit the discharge of oil" are inadequate; and it opposes the very steps which could keep all but accidentally spilled oil out of the oceans.

Texaco is the third largest energy company in the U.S., and it is the world's tenth largest industrial concern. It has interests in oil, coal, gas shale and uranium, and manufactures a broad spectrum of petroleum products. Texaco bills itself as the only U.S. oil company which markets its products under the same name in all 50 states. The firm's primary interest is the production of petroleum, and its holdings span the world from Alaska to Indonesia.

The International Conventions mentioned in the advertisement refer to an agreement reached in 1954 and subsequently amended in 1962 which places a limitation of 100 parts per million (ppm) on the concentrations of oil which may be discharged within 50 miles of any coast and within 100 miles or more of certain heavily travelled areas, such as ports. As the advertisement implies, there is no limitation of discharges of oil into the ocean beyond these boundaries.

Prior to this treaty, there were several common tanker operating procedures likely to dump oil directly into the ocean — as much as 1200 barrels from a medium-sized vessel. Tankers balance the distribution of weight by using ocean water as ballast. After unloading at a port, sea water may be pumped into the empty tank to balance the ship. When it is necessary to deballast that tank, the water, now mixed with the oil that had remained in the tank after unloading, is discharged into the ocean. Similarly, when tanks are flushed with sea water for cleaning, oil is mixed with the discharged water.

Before the curbs were adopted, pollution from this process amounted to at least 2 million tons annually. In response to the treaty, the industry adopted the "load on top" procedure of reducing oil effluent. Seventy-five to eighty percent of the world's tankers are not equipped to use this procedure. The new process involves gathering the slops remaining after the tanker holds are cleaned and deballasted into a single compartment. The liquid is kept until the oil and water separate, at which point the water is allowed to drain off the bottom. In theory the new method is more effective, but there is no check on the amount of oil still mixed with the discharge. Some sources estimate that the concentration of oil is as high as 400 to 500 ppm. Furthermore, there is no monitoring of the point at which the discharge of water reaches the interface with the oil. According to an old industry film, the usual procedure involves having a crew member lean over the rail to watch the discharge until it turns black, indicating that the upper layer of oil has been reached. It is this procedure which Texaco refers to when it states that "only clean water ballast" is discharged.

It is difficult to verify Texaco's claim that its tankers use no other procedure than the load on top process. The Coast Guard patrols the coast only a few times each week; and its patrols never move beyond a 12 mile distance from shore. Tankers have been known to choose nighttime to discharge wastes, since this is an opportunity to escape detection. Since the U.S. ratified the international treaty, the Coast Guard has never discovered an American vessel in violation of the requirement.

Another problem is the difficulty in determining whether a vessel emitting a slick is in violation of the 100 ppm limitation set by the treaty. On September 11, 1969 a Canadian pilot spotted the Texaco vessel *Mississippi* trailing a heavy slick of oil for approximately 35 miles. A complaint was lodged with the State Department, and, after a circuitous route, the matter came under the control of the Coast Guard, which has filed suit against the master of the ship for violating the treaty. If the Canadian pilot's description of the slick and the supporting testimony of a chemical engineer are accepted as convincing evidence against Texaco, a valuable court precedent will be set.

Although Texaco's pollution record is relatively clean, the company has been involved in at least two known major pollution violations in addition to the *Mississippi* case. Texaco was one of the companies responsible for the massive Santa Barbara blowout, and its share of the clean-up costs amounted to $1.25 million. Texaco was also one of thirteen companies charged in January of 1970 with polluting the waters of the Newark Bay, which flow into the New York harbor. The company did not contest the charge and was fined $500.

The oil industry's public relations statements, like this advertisement, argue that the value of the oil retained provides the incentive to recover the petroleum residue after tanker cleanings. Yet there are special refining procedures required for oil which is contaminated with salt water, and it is not clear whether Texaco has adequate onshore facilities to make the recovery of all its oily wastes profitable. One rough survey listed Texaco as having an onshore capacity of slightly over 82,000 barrels for holding oil and water wastes. Texaco transports over water close to 1 million barrels a day. Sources close to the industry doubt whether Texaco refineries are equipped to hold all the wastes from these tankers.

The proposal at the recent NATO conference on oil pollution to place an absolute ban on oil discharges was introduced by U.S. Secretary of Transportation John Volpe. This measure is recognized by environmentalists as being the only practical solution to limiting water pollution due to oil. In spite of the improvements in tanker technology developed during the 1960s, amounts of oil dumped into water are creeping beyond pre-load-on-top levels. Lumps of crude oil littering the ocean have become increasingly common. Several species of fish have been discovered to feed off them. Recent scientific findings show that certain poisonous hydrocarbons which are components of oil are retained in fish tissues and thus enter the marine food chains. With the growing world dependence upon the ocean for protein foods, the threat posed by oil is all too apparent.

Texaco claims the costs of the Volpe no-dump proposal would outweigh the benefits, though there are no figures regarding the price of such a restriction. Coming from a company which cleared a profit of $769,804,000 last year – on which it paid federal taxes of less than one percent – this complaint seems unjustified. Furthermore a great deal of the oil moved in ocean tankers is imported into the U.S. Import tickets are distributed by the federal government to oil firms. Because of the price differential between foreign and domestic oil, these tickets are immensely valuable. In 1969 Texaco received tickets, essentially gifts, worth $13.3 million.

In a telephone interview, a Texaco spokesman would not say whether the company supports a new, less stringent limitation on oil pollution proposed by the International Maritime Consultation Organization. Texaco indirectly played an advisory role during the drafting of the measure, and the oil industry is generally in favor of it. The treaty would impose an absolute limit upon the amount of oil – 60 liters per nautical mile – that could be discharged by tankers. Under typical operating conditions the 100 ppm requirement of the existing treaty results in a discharge of 2.2 liters per nautical mile. Thus the new treaty would be 25 times less restrictive. Even the present limitation may not be strict enough, for experiments carried out by the Ministry of Transport in England suggest that 1.3 liters of oil per mile may be the highest rate that the oceans can tolerate without bringing permanent damage to marine life.

Until regulations are amended to prohibit the discharge of any water contaminated with oil, oil will continue to dribble steadily into the oceans during ordinary tanker operating procedures. Texaco specifically opposes such regulations, and euphemistically refers to the oily wastes which they would prevent as "clean salt-water ballast." Far from prohibiting the pollution of the sea with oil, Texaco actually endorses it.

Eric Little

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Adapted from materials prepared by Project Coast.

DEBUNKING MADISON AVENUE (TEXACO)

I. Read the following statements carefully. Check those statements that are actually stated or paraphased in the article. Be ready to explain what is inaccurate about the statements that you do not check.

____1. The advertisement from Texaco oil states that Texaco tankers never discharge oily wastes at sea and that Texaco supports all practical proposals to stop any oil tankers from dumping oily waters at sea.

____2. Oil is sometimes flushed into the ocean when ocean water is used as balllast.

____3. Almost all of the world's tankers now use a process called "load on top" to reduce oil effluent (waste).

____4. Detection of oil tanker polluters is an easy matter.

____5. The amount of oil pollution is increasing in spite of improvements in tanker technology.

____6. Texaco opposes more restrictive regulations on the amount of oil waste permitted.

II. The following generalizations may or may not be true, based upon what the author implies. Check those that you feel can be supported by the article. Be ready to support your opinions..

____1. Oil companies are using the media (newspapers, television, etc)·to improve their image as pollution fighters.

____2. Texaco oil has done everything it possibly can to prevent oily tanker wastes from entering the ocean.

____3. At Texaco oil, what they say and what they do are very different.

____4. The author feels that we do no know enough about the effect of oil on the ocean ecosystem to allow oil tankers to dump oily waster into the seas.

____5. We can believe everything we read in advertisements.

SEND - IN PAGE

Well, you've made it. Thank you for teaching about the marine environment. We worked hard to put this unit together and we would really like to hear from you. If you have any reactions (positive or negative) that could help us, please let us know. We are also interested in any changes you made in the activities which you feel made them more useful. If you have some marine activities that you have tried successfully with children, we would like to know about them also. Perhaps we can help you share your working ideas with other teachers concerned with the marine environment. Again thanks, and keep up the good work.